DOCUMENT RESUME

ED 425 078	SE 061 905
AUTHOR	O'Sullivan, Christine Y.; Weiss, Andrew R.; Askew, Janice M.
TITLE	Students Learning Science: A Report on Policies and Practices in U.S. Schools.
INSTITUTION	National Assessment of Educational Progress, Princeton, NJ.; Educational Testing Service, Princeton, NJ.
SPONS AGENCY	National Center for Education Statistics (ED), Washington, DC.
REPORT NO	NCES-98-493
ISBN	ISBN-0-16-049733-7
PUB DATE	1998-09-00
NOTE	152p.
AVAILABLE FROM	ED Pubs, P.O. Box 1398, Jessup, MD 20794-1398; Tel: 877-433-7827 (Toll-free); Web site: http://nces.ed.gov/naep
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	*Course Selection (Students); *Educational Policy; Elementary Secondary Education; Knowledge Base for Teaching; Learning Strategies; *Science Curriculum; Standards; *Student Evaluation
IDENTIFIERS	National Assessment of Educational Progress; Office of Educational Research and Improvement

ABSTRACT

This report on teachers' academic preparation and professional development, the amount of emphasis science instruction receives in schools, student course taking, and the availability of school resources that support science learning is intended primarily for policy makers, school administrators, and educators concerned with state- or school-level policies. Data is drawn from the 1996 National Assessment of Educational Progress (NAEP) and results are presented using the students as the unit of analysis. Appendises present an overview of procedures used for the NAEP 1996 Science Assessment and standard errors. Contains 14 figures and 25 tables. (DDR)

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STUDENTS LEARNING SCIENCE

A REPORT ON POLICIES AND PRACTICES IN U.S. SCHOOLS

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Students Learning Science: A Report on Policies and Practices in U.S. Schools

Christine Y. O'Sullivan
Andrew R. Weiss
Janice M. Askew

September 1998

Prepared by Educational Testing Service under a cooperative agreement with the National Center for Education Statistics

U.S. Department of Education
Office of Educational Research and Improvement NCES 98-493

For sale by the U.S. Government Printing Office
Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402-9328
ISBN 0-16-049733-7

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SUGGESTED CITATION

O'Sullivan, C.Y., Weiss, A.R., & Askew, J.M. (1998). *Students learning science: A report on policies and practices in U.S. schools.* Washington, DC: National Center for Education Statistics.

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This report also is available on the World Wide Web: http://nces.ed.gov/naep.

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Highlights

The 1996 National Assessment of Educational Progress (NAEP) in science continues a 27-year mandate to report what students in grades 4, 8, and 12 know and can do in various subject areas. This report is intended primarily for policy makers, school administrators, and educators concerned with state or school-level policies. It presents results relating to teachers' academic preparation and professional development, the amount of emphasis science instruction receives in schools, student course-taking, and the availability of school resources that support science learning. The results are presented using the students as the unit of analysis. Scale scores are reported on a 300-point NAEP scale whereas the achievement level results are expressed as percentages of students at or above the *Proficient* level in accordance with standards developed by the National Assessment Governing Board (NAGB).

What's New About The Science Assessment?

- The NAEP 1996 science assessment was the first science assessment given using a framework developed by the Council of Chief State School Officers (CCSSO) under the auspices of the NAGB. The framework provides for an assessment of knowledge and skills in three major science domains — earth science, physical science, and life science.
- The assessment included hands-on tasks that probed students' abilities to use materials to make observations, perform investigations, evaluate experimental results, and apply problem-solving skills. Also included were multiple-choice questions that assessed students' knowledge of important facts and concepts and probed their analytical reasoning skills, and constructed-response questions that explored students' abilities to explain, integrate, apply, reason about, plan, design, evaluate, and communicate scientific information.

Who is Teaching Science to the Nation's Fourth- and Eighth-Grade Students?

- Approximately three-fifths of students in grades 4 and 8 were taught by teachers who reported that their highest degree was a bachelor's degree.
- At the fourth and eighth grades, 16 and 62 percent, respectively, of the nations' students were taught by teachers who reported holding an undergraduate or graduate major or minor in science or science education.
- Approximately one-quarter of grade 4 public school students and three-quarters of grade 8 public school students had teachers who reported that they were certified in the area of science.
- Teachers of approximately 46 percent of fourth and eighth graders reported having 11 or more years of science teaching experience.

What Emphasis Does Science Receive?

- According to school administrators, 87 percent of fourth-grade students and 99 percent of eighth-grade students received instruction in science three or more times a week.
- Twenty-six percent of twelfth graders reported taking six or seven semesters of science and 29 percent reported taking eight or more semesters of science from grades 9 through 12.

What Science Courses Are Our Nation's Students Taking?

- Between 40 and 50 percent of grade 8 students were taught by teachers who reported spending a lot of time teaching earth science and physical science. Nineteen percent of students had teachers who indicated that they had spent a lot of time teaching life science.
- At grade 12, 53 percent of students reported having taken earth and space science, 96 percent biology, 74 percent chemistry, and 41 percent physics.
- Male students who reported having taken biology, chemistry, and physics outperformed female students who reported having taken these same courses.
- In general, students who reported having taken chemistry and physics among their science courses performed at a higher level than students who reported not having taken them.
- Fifty-four percent of grade 12 students reported that they were currently taking a science course, whereas 46 percent reported that they were not currently taking one.

Do Schools Have the Resources They Need to Support Science Learning?

- Nationally, teachers of 59 percent of fourth graders and 65 percent of eighth graders reported receiving all or most of the resources they needed.
- Teachers of approximately 15 percent of students in grades 4 and 8 reported having no access to computers.
- Teachers of approximately 53 percent of students in grade 4 and 38 percent of students in grade 8 reported having access to one or more computers in the classroom.
- Forty-five percent of fourth graders and 40 percent of eighth graders had teachers who reported having a curriculum specialist available in science.

Chapter 1

The NAEP 1996 Science Assessment

Introduction

The current impetus in educational reform has its roots in a report entitled *A Nation at Risk* that was issued in 1983 by the National Commission on Excellence in Education. The report was critical of education in the United States and raised the concern that national student achievement across core subject areas was eroding.[1] In the 15 years since the publication of *A Nation at Risk*, many studies have been conducted that point out deficiencies in the educational system and suggest how they can be rectified.[2] Some evidence for these deficiencies can be found in reports such as the *NAEP 1996 Trends in Academic Progress*, which has been tracking student performance in science since 1969-1970.[3] The NAEP trend report revealed declines in the overall science performance of 9-, 13-, and 17-year-olds during the late 1970s, followed by improvements in the 1980s. While the average performance of 9-year-olds was higher in 1996 than in 1970, the performance of 13-year-olds was the same as in 1970 and the performance of 17-year-olds was still below its 1969 level.[4]

Two recent documents by prestigious science organizations have offered consensus views on what content is most important to teach. In 1993 the American Association for the Advancement of Science published *Benchmarks for Science Literacy*, which consisted of "statements of what *all* students should know and be able to do in science, mathematics, and technology."[5] In 1995 the National Research Council of the National Academy of Sciences

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[1] National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform.* Washington, DC: Author.

[2] National Science Board. (1983). *Commission on precollege education in mathematics, science, and technology, educating America for the 21st century: A report to the American people and the National Science Board.* Washington, DC: Author.

Eisenhower Mathematics and Science Regional Consortia. (1995) *Promising practices in mathematics and science education.* Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Wheatley, G. H. (1991). Constructivist perspectives on science and mathematics learning. *Science Education Journal 75* (1): 9-12.

[3] Campbell, J. R., Voelkl, K. E., & Donahue, P. L. (1997). *NAEP 1996 trends in academic progress: Achievement of U.S. students in science 1969 to 1996; mathematics, 1973 to 1996; reading, 1971 to 1996; and writing, 1984 to 1996.* (Publication No. NCES 97-985). Washington, DC: National Center for Education Statistics.

[4] Ibid.

[5] American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* Washington, DC: Author.

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released *National Science Education Standards*, which articulated "a vision of science education that will make scientific literacy for all a reality in the 21st century."[6] The *National Science Education Standards* also includes recommendations for teachers and other science educators on teacher education, assessment, and professional development.

Central to the calls for reform of science education are concerns about how science education can equip students with the knowledge and skills necessary for success in a technological world and how the United States can remain competitive in a global economy. Given these concerns, policymakers have been especially interested in the findings of the Third International Mathematics and Science Study (TIMSS). TIMSS examined the educational systems in a large number of countries in terms of student achievement, curriculum coverage, and teaching methodologies.[7] At the fourth-grade level, results revealed that students in the U.S. performed above the international average in science and were outperformed by only students from Korea.[8] At the eighth-grade level, U.S. students performed above the international average in science; however, students in 11 countries had significantly higher average scores than students in the U.S.[9] At the twelfth-grade level, U.S. students performed significantly below the international average in "science literacy," and in physics, the U.S. had significantly lower achievement than every participating country except one.[10] The TIMSS study will be repeated at the eighth-grade level in 1999 and will assess the same cohort as was assessed in 1995 at the fourth-grade level. It will provide a valuable comparison of student scale.scores between 1995 and 1999 as well as a new indicator of how well the nations' eighth graders are doing in science and mathematics when compared to their counterparts in other countries.

State and school policies and practices regarding how science is taught, how science teachers are prepared, and the emphasis science receives in school are some of the factors that determine how well students achieve. While it is too soon to ascertain whether reforms proposed for science education are achieving their desired goals at state and local levels, the NAEP 1996 science assessment provides an opportunity to examine current policies and

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[6] National Research Council of the Academy of Sciences. (1995). *National science education standards*. Washington, DC: Author.

[7] Martin, M.O., Mullis, I.V.S., Beaton, A.E., Gonzalez, E.J., Smith, T.A., & Kelly, D.L. (1997). *Science achievement in the primary school years: IEA's third international mathematics and science study*. Chestnut Hill, MA: Center for the Study of Testing, Evaluation, and Educational Policy, Boston College.

Peak, et al. (1997). *Pursuing excellence: a study of U.S. eighth-grade mathematics and science teaching, learning, curriculum, and achievement in international context*. Washington, DC: National Center for Education Statistics.

Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., & Smith, T. (1998). *Mathematics and science achievement in the final year or secondary school: IEA's third international mathematics and science study (TIMSS).* Chestnut Hill, MA: TIMSS International Study Center, Boston College.

Beaton, A.E. Martin, M.O., Mullis, I.V.S., Gonzalez, E. J., Smith, T.A., and Kelly, D.L. (1996) *Science achievement in the middle years: IEA's third international mathematics and science study (TIMSS).* Chestnut Hill, MA: TIMSS International Study Center, Boston College.

Schmidt, W.H., McKnight, C.C., & Razien, S.A. (1996). *Splintered vision: An investigation of U.S. science and mathematics education*. Norwell, MA: Kluwer Academic Publishers.

Schmidt, W.H., Raizen S.A., Briton, E.D., Bianchi, L.J., & Wolfe, R.G. (1996). *Many visions, many aims: A cross-national investigation of curricular intentions in school science*. Norwell, MA: Kluwer Academic Publishers.

[8] Twenty six countries took part in the study at the fourth grade level, 17 of which satisfied study guidelines.

[9] At the eighth-grade level, 41 countries participated in TIMSS, 25 of which satisfied study guidelines.

[10] At the twelfth-grade level, 21 countries participated in the science literacy component, eight of which satisfied study guidelines. Sixteen countries participated in the physics component, of which 10 satisfied study guidelines.

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practices. This report was written using data collected from students, teachers, and school administrators during the NAEP 1996 science assessment. It is intended primarily for policymakers, school administrators, and educators concerned with state- or school-level practices. The data provide a "snapshot" of current teacher practices, school policies, and student achievement that will allow comparisons to be made when the NAEP science assessment is re-administered in the year 2000 and beyond.

The NAEP Science Framework

The science assessment was designed to measure the content and skills described in the *Science Framework for the 1996 National Assessment of Educational Progress.*[11] The framework was developed in 1991 through a consensus process involving educators, policymakers, science teachers, representatives of the business community, assessment and curriculum experts, and members of the public. The project was managed by the Council of Chief State School Officers (CCSSO) under the auspices of the National Assessment Governing Board (NAGB).

The NAEP science framework is based on the view that "scientific knowledge should be organized to provide a structure that connects and creates meaning for factual information, and this organization is influenced by the context in which the knowledge is presented." Moreover, "science proficiency depends upon the ability to know and integrate facts into larger constructs and to use the tools, procedures, and reasoning processes of science for an increased understanding of the natural world."[12] Thus, the framework called for the NAEP 1996 science assessment to include the following:

- multiple-choice questions that assess students' knowledge of important facts and concepts and probe their analytical reasoning skills;
- constructed-response questions that explore students' abilities to explain, integrate, apply, reason about, plan, design, evaluate, and communicate science information; and
- hands-on tasks that probe students' abilities to use materials to make observations, perform investigations, evaluate experimental results, and apply problem-solving skills.

A description of the content coverage and assessment design is presented in Appendix A.

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[11] National Assessment Governing Board. (1995). *Science framework for the 1996 National Assessment of Educational Progress.* Washington, DC: Author.

[12] Ibid.

Student Samples

The NAEP 1996 science assessment was conducted nationally at grades 4, 8, and 12, and at the state level at grade 8. For both the national and state-by-state assessments, representative samples of public and nonpublic school students were assessed.

Forty-three states, the District of Columbia, Guam, the Department of Defense Domestic Dependent Elementary and Secondary Schools (DDESS), and the overseas Department of Defense Dependents Schools (DoDDS) participated in the 1996 state-by-state assessment. For the purposes of this report, these are referred to as "jurisdictions." Figure 1.1 lists the jurisdictions that participated in the assessment and notes those jurisdictions that failed to meet one or more of the established participation-rate guidelines for public schools. For many of the jurisdictions participating in the assessment, the sample of nonpublic school students was not large enough to permit the separate reporting of nonpublic school results or the combined reporting of public and nonpublic school results. Therefore, the figures and tables displaying data for the jurisdictions refer to public schools only.

A more detailed description of the sample, sampling procedures, and public school and nonpublic school participation rates can be found in the Procedural Appendix of the *NAEP 1996 Science Report Card.*[13]

FIGURE 1.1

Jurisdictions Participating in the NAEP 1996 State Assessment Program in Science, Grade 8

Alabama
Alaska[a]
Arizona
Arkansas[a]
California
Colorado
Connecticut
Delaware
DDESS
DoDDS
District of Columbia
Florida
Georgia
Guam
Hawaii
Indiana
Iowa[a]
Kentucky
Louisiana
Maine
Maryland[a]
Massachusetts
Michigan[a]
Minnesota
Mississippi
Missouri
Montana[a]
Nebraska
Nevada[b]
New Hampshire[b]
New Jersey[b]
New Mexico
New York[a]
North Carolina
North Dakota
Oregon
Rhode Island
South Carolina[a]
Tennessee
Texas
Utah
Vermont[a]
Virginia
Washington
West Virginia
Wisconsin[a]
Wyoming

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

[b] Failed to meet the initial school participation rate of 70 percent for public schools; public school results not reported.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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[13] O'Sullivan, C.Y., Reese, C.M., & Mazzeo, J. (1997). *NAEP 1996 science report card for the nation and the states: Findings from the National Assessment of Educational Progress* (Publication No. NCES 97-499). Washington, DC: National Center for Education Statistics.

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Background Questionnaires

In order to place student achievement in context, NAEP collects background information from teachers, school administrators, and students. The teacher questionnaires were administered to the science teachers of all of the fourth- and eighth-grade students participating in the assessment. Because twelfth-grade students were not necessarily enrolled in science, no questionnaires were administered to twelfth-grade science teachers. The teacher questionnaire consisted of three sections and took approximately 20 minutes to complete. The first section focused on the teacher's general background and experience, the second section focused on the teacher's science background, and the third section focused on classroom science instruction. Because the sampling for the teacher questionnaire was based on participating students, the responses to the science teacher questionnaire do not necessarily represent all fourth- or eighth-grade science teachers in the nation or in a state. Rather, they represent the teachers of the representative sample of students assessed.

The school characteristics and policy questionnaire was given to the principal or other administrator in each participating school and required about 20 minutes to complete. The questions asked about the principal's background and experience; school policies, programs, and facilities; and the demographic characteristics and background of the students and teachers in that school.

Each student booklet also contained three sets of student background questions. The first set collected general information about students' race or ethnicity; parents' level of education; number and type of reading materials in the home; amount of time spent on homework; and student's academic expectations. The second set was directed specifically at students' science background and included questions about science instructional activities, science courses taken, use of specialized resources such as computers and laboratory equipment, and students' views on the utility and value of science. The third set contained five questions about students' motivation to do well on the assessment, their perception of the difficulty of the assessment, and their familiarity with the types of cognitive questions included. Students at grades 8 and 12 were given five minutes to complete each set of background questions. Fourth graders were given more time because the general background questions were read aloud to them.

It is important to note that in this report, as in all NAEP reports, the student is the unit of analysis, even when information from teacher or school questionnaires is reported. This is because the sampling for the teacher and school questionnaires was based on participating students and does not represent all teachers or schools in the nation or in a state. For example, when discussing the educational background of science teachers, NAEP can report that 45 percent of eighth-grade students were taught science by teachers who reported having an undergraduate or graduate major in science but cannot report that 45 percent of all the nation's teachers have an undergraduate or graduate major in science.

Reporting NAEP Results

The NAEP Science Scale

The NAEP science scale is a composite scale that ranges from 0 to 300 with a mean of 150 and a standard deviation of 35. While the scale-score ranges are identical, the scale was derived independently at each of the three grades. Also, scales were weighted differently at different grades in determining the overall scale. Therefore, average scale scores across grades cannot be compared. For example, equal scale scores on the grade 4 and grade 8 scales do not imply equal levels of science achievement. A more detailed account of scaling procedures has been included in Appendix A.

Achievement Levels for Student Performance

Since 1988, NAGB has been required by law to set performance standards — called achievement levels — for NAEP.[11] Summary descriptions of the definitions of the science achievement levels, *Basic, Proficient,* and *Advanced,* are found in Figure 1.2. It should be noted that achievement level descriptions are cumulative, that is, students performing at the *Proficient* level should have all of the knowledge and skills of students at the *Basic* level, and students performing at the *Advanced* level should have all of the knowledge and skills of students performing at the *Proficient* and *Basic* levels. A more complete description of the achievement levels is presented in Appendix A. In the current report, the percentages of students performing at or above the *Proficient* level are included whenever scale scores are presented in the tables except when the scale scores are for student performance in any one of the three science domains. The NAGB did not set achievement levels for performance within single domains.

Cautions in Interpretation

There are several cautions that readers of this report should bear in mind as they look at the data presented. The first caution relates to the information collected from responses to the background questionnaires. This information is self-reported and, while the questions are written as unambiguously as possible, interpretations may vary based on such factors as differing educational and teaching experiences. The second caution relates to interpreting as causal the relationships among student, school, and teacher variables and student performance. In particular, it is inappropriate to draw conclusions about the relative effectiveness of school policies, teaching approaches, or student experiences solely on the basis of the data in this report because multiple interrelated factors contribute to student outcomes in education. While the data reported here are cross-sectional, learning is cumulative. The variables examined in this report such as, for example, the availability of resources, reflect a single year and do not reflect what students have experienced in three, seven, or eleven years of previous schooling. It should also be noted that the absence of statistical correlation between variables and student performance should

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[11] Bourque, M. L., Champagne, A. B., & Crissman, S. (1997). *1996 science performance standards: Achievement results for the nation and the states.* Washington, DC: National Assessment Governing Board.

FIGURE 1.2

Summary of the 1996 NAEP Science Achievement Level Descriptions

THE NATION'S REPORT CARD naep

Cut Score	Content Descriptions
Grade 4	
BASIC *138*	Students performing at the *Basic* level demonstrate some of the knowledge and reasoning required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 4. For example, they can carry out simple investigations and read uncomplicated graphs and diagrams. Students at this level also show a beginning understanding of classification, simple relationships, and energy.
PROFICIENT *170*	Students performing at the *Proficient* level demonstrate the knowledge and reasoning required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 4. For example, they understand concepts relating to the Earth's features, physical properties, and structure and function. In addition, students can formulate solutions to familiar problems as well as show a beginning awareness of issues associated with technology.
ADVANCED *205*	Students performing at the *Advanced* level demonstrate a solid understanding of the earth, physical, and life sciences as well as the ability to apply their understanding to practical situations at a level appropriate to Grade 4. For example, they can perform and critique simple investigations, make connections from one or more of the sciences to predict or conclude, and apply fundamental concepts to practical applications.
Grade 8	
BASIC *143*	Students performing at the *Basic* level demonstrate some of the knowledge and reasoning required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 8. For example, they can carry out investigations and obtain information from graphs, diagrams, and tables. In addition, they demonstrate some understanding of concepts relating to the solar system and relative motion. Students at this level also have a beginning understanding of cause-and-effect relationships.
PROFICIENT *170*	Students performing at the *Proficient* level demonstrate much of the knowledge and many of the reasoning abilities essential for understanding of the earth, physical, and life sciences at a level appropriate to Grade 8. For example, students can interpret graphic information, design simple investigations, and explain such scientific concepts as energy transfer. Students at this level also show an awareness of environmental issues, especially those addressing energy and pollution.
ADVANCED *208*	Students performing at the *Advanced* level demonstrate a solid understanding of the earth, physical, and life sciences as well as the abilities required to apply their understanding in practical situations at a level appropriate to Grade 8. For example, students perform and critique the design of investigations, relate scientific concepts to each other, explain their reasoning, and discuss the impact of human activities on the environment.
Grade 12	
BASIC *146*	Students performing at the *Basic* level demonstrate some knowledge and certain reasoning abilities required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 12. In addition, they demonstrate knowledge of the themes of science (models, systems, patterns of change) required for understanding the most basic relationships among the earth, physical, and life sciences. They are able to conduct investigations, critique the design of investigations, and demonstrate a rudimentary understanding of scientific principles.
PROFICIENT *178*	Students performing at the *Proficient* level demonstrate the knowledge and reasoning abilities required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 12. In addition, they demonstrate knowledge of the themes of science (models, systems, patterns of change) required for understanding how these themes illustrate essential relationships among the earth, physical, and life sciences. They are able to analyze data and apply scientific principles to everyday situations.
ADVANCED *210*	Students performing at the *Advanced* level demonstrate the knowledge and reasoning abilities required for a solid understanding of the earth, physical, and life sciences at a level appropriate to Grade 12. In addition, they demonstrate knowledge of the themes of science (models, systems, pattern of change) required for integrating knowledge and understanding of scientific principles from the earth, physical, and life sciences. Students can design investigations that answer questions about real-world situations and use their reasoning abilities to make predictions.

SOURCE: National Assessment Governing Board (NAGB), National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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not necessarily be interpreted to mean that there is no cause-and-effect relationship between them because the effects may in fact be masked by other factors. By the same token, when there are apparent statistical correlations, it is also impossible to assign cause and effect to a single variable because a single variable will rarely be the sole determinant of higher achievement.

Additional NAEP Science Reports

A number of reports will be written addressing different aspects of the NAEP 1996 science assessment. Three reports are already completed: the *NAEP 1996 Science Report Card for the Nation and the States,* which examines and compares the science performance of groups of students defined by demographic characteristics or by responses to background questions (e.g., males compared to females); a companion report, *1996 Science Performance Standards: Achievement Results for the Nation and the States,* which presents the NAGB's achievement levels within the context of demographic variables; and *What Do Students Know?,* a summary of the NAEP 1996 science results.[15] Several reports that draw on select portions of NAEP data will target specific audiences. In addition to the current report for policymakers, a second report, directed primarily at teachers, is currently in preparation. This second report addresses student work in science and presents samples of assessment questions, scoring guides, and student responses. A third report will discuss some of the special features of the NAEP 1996 science assessment, including hands-on tasks, theme blocks, and constructed-response items. It will also present results from a special study that assessed students with advanced training in science This study was conducted in conjunction with the main NAEP 1996 science assessment. The NAEP 1996 science assessment provided a wealth of information, not all of which will appear in reports. Summary data tables from the assessment are available on the World Wide Web at http://nces.ed.gov/naep.

Overview of Remaining Chapters

Chapter 2 of the report presents results related to teachers' academic preparation and professional development. Chapter 3 discusses data concerning the amount of emphasis science instruction receives in schools, including the availability of advanced courses and the amount of science required for graduation. Student course taking is the focus of Chapter 4. Chapter 5 examines the availability of school resources that support science learning. Finally, the report contains two appendices that support or augment the information and results presented in the main text.

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[15] O'Sullivan, C.Y., Reese, C.M., & Mazzeo, J. (1997). *NAEP 1996 science report card for the nation and the states: Findings from the National Assessment of Educational Progress* (Publication No. NCES 97-499). Washington, DC: National Center for Education Statistics.

Bourque, M. L., Champagne, A. B., & Crissman, S. (1997). *1996 science performance standards: Achievement results for the nation and the states.* Washington, DC: National Assessment Governing Board.

National Assessment Governing Board. (1997). *What do students know?* Washington, DC: Author.

Chapter 2

Who is Teaching Science to the Nation's Fourth- and Eighth-Grade Students?

How learning takes place in the classroom, what content is taught, and how assessment is integrated with teaching and learning are key areas of concern in science education reform.[1] Another concern is whether teachers are adequately prepared to teach science.[2] It has been argued that if teachers are to make sense of the changes that are taking place in science education and impart to students the knowledge and skills necessary to achieve scientific literacy, it is imperative that they have the prerequisite content and pedagogical knowledge that documents such as the *National Science Education Standards* and *Benchmarks for Science Literacy* advocate.[3] Data collected during the NAEP 1996 science assessment provide information related to various aspects of teacher preparedness such as academic background, certification, years of teaching experience, and professional development activities. Chapter 2 discusses these data.

Performance data are included in the tables of this chapter. Readers should be aware that the relationships between teacher variables and student performance are complex. When apparent statistical correlations are present it is impossible to assign cause and effect to a single variable. Similarly an absence of correlation between variables and student performance does not necessarily mean that no cause-and-effect relationships exist; they may, in fact, be masked by other factors.

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[1] American Association for the Advancement of Science. (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics, and technology.* Washington, DC: Author.

National Science Teachers Association. (1992). *Scope, sequence, and coordination of secondary school science curriculum designers* (Vol. I.). *The content core: A guide for curriculum developers.* Washington, DC: Author.

[2] Gee, C.J., & Gabel, D.L. (1996). *The first year in teaching: Science in the elementary school.* A paper presented at the annual meeting of the National Association for Research in Science Teaching, St. Louis, MO.

Loucks-Horsly, S., Bybee, R., & Wild, E.L.C. (1996, November). "The role of community colleges in the professional development of science teachers." *Journal of College Science Teaching,* 26(2) 130-135.

National Science Teachers Association. (1992). *NSTA certification requirements.* Arlington, VA, Author.

[3] National Research Council of the Academy of Sciences. (1995). *National science education standards.* Washington, DC: Author.

American Association for the Advancement of Science. (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics, and technology.* Washington, DC: Author.

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Academic Training

The academic training of teachers of fourth-and eighth-grade students can be determined from data collected during the NAEP 1996 science assessment. Table 2.1 summarizes teachers' reports of their highest academic degree in the following categories: public and nonpublic schools combined, public schools only, and nonpublic schools only. In public and nonpublic schools, 59 percent of students in grade 4 and 57 percent of students in grade 8 were taught by teachers who had earned a bachelor's degree but not a higher degree. Forty percent of fourth graders and 42 percent of eighth graders were taught by teachers who had received a master's degree or an education specialist's degree. An additional 1 percent of students at the eighth-grade level were taught science by teachers who had a doctorate or professional degree.[4] Similar results were obtained in the NAEP 1990 science assessment when teachers of grade 8 students were asked to report their highest academic degree. At that time, 53 percent of students were taught by teachers who reported having a bachelor's degree and 47 percent had teachers with a master's or education specialist's degree. In that year, no students were taught by teachers with a doctorate or professional degree.[5] An analysis of scale scores and achievement level data of fourth- and eighth-grade students revealed that student performance did not vary with the highest level of academic degree their teachers held.

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[4] Identical information concerning teacher qualifications was requested of mathematics teachers whose students took part in the NAEP 1996 mathematics assessment. Their level of education was found to be similar to that of science teachers. National Center for Education Statistics. National Assessment of Educational Progress. (1997). *1996 Mathematics assessment summary data tables* [On-line]. Available: http://nces.ed.gov/naep/tables96/index.shtml.

[5] Jones, L. R., Mullis, I. V. S., Raizen, S. A., Weiss, I. R., & Weston, E. A. (1992). *The 1990 science report card.* Washington, DC: National Center for Education Statistics.

TABLE 2.1 Teachers' Reports on Their Highest Degree, by Type of School

THE NATION'S REPORT CARD

What is the highest academic degree you hold?	Grade 4			Grade 8		
	Public and Nonpublic Schools	Public Schools Only	Nonpublic Schools Only	Public and Nonpublic Schools	Public Schools Only	Nonpublic Schools Only
	Percentage, Average Scale Score, and Achievement Level of Students					
High School, Associates Degree, or Vocational Certification						
Percentage of Students	1	0	8	0	0	0
Average Scale Score	—	—	—	—	—	—
Percentage At or Above *Proficient*	—	—	—	—	—	—
Bachelor's						
Percentage of Students	59	57	72	57	55	70
Average Scale Score	150	148	166	150	148	161
Percentage At or Above *Proficient*	29	26	46	29	27	40
Master's or Specialist's						
Percentage of Students	40	42	20	42	44	28
Average Scale Score	152	151	164	154	153	167
Percentage At or Above *Proficient*	31	31	42	33	32	49
Doctorate or Professional						
Percentage of Students	—	—	—	1	1	2
Average Scale Score	—	—	—	142	134	—
Percentage At or Above *Proficient*	—	—	—	23	14	—

— Sample size insufficient to permit a reliable estimate.

NOTE: Numbers may not add up to 100 due to rounding.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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A comparison of the qualifications of teachers in public and nonpublic schools reveals differences. In public schools, students in grades 4 and 8 were more likely to be taught science by teachers with a master's or specialist's degree than were their counterparts in nonpublic schools. At grade four, 42 percent of public school students were taught by teachers who held a master's or specialist's degree, compared to 20 percent in nonpublic schools. Similarly, in the eighth grade, 44 percent of public school students were taught by teachers who held a master's or specialist's degree, compared to 28 percent in nonpublic schools. Eight percent of nonpublic school fourth-grade students had teachers who held a high school diploma, associate degree, or vocational certificate.

Although more public school students were taught by teachers who hold advanced degrees than nonpublic school students, past NAEP results across a variety of subjects, including science, have consistently shown that students attending nonpublic schools outperformed students attending public schools.[6] Studies have shown, however, that if one adjusts for the effects as students' home background and schools' socioeconomic environment, much of the difference in performance between students in public schools and students in private schools disappears.[7]

Several surveys have been conducted in recent years on the status of the American public school teacher that provide information related to that collected by NAEP. Data from the Schools and Staffing Survey, 1993-1994, show that the highest degree earned by approximately 40 percent of elementary public school teachers and 44 percent of secondary school teachers was a master's degree. Fewer than one percent of elementary school teachers held a doctoral degree whereas just over one percent of secondary school teachers held one.[8] A survey conducted by the National Education Association (NEA) shows that during the 1995-1996 school year approximately 55 percent of public school teachers held a master's degree or a 6-year diploma and approximately 2 percent held doctoral degrees. In 1961 the percentage of teachers holding postgraduate degrees was approximately 23 percent. While the NEA survey data show that the educational level of teachers has improved dramatically over the past 35 years, it should be noted that this increase took place during the 1960s and 1970s. NEA data indicate that the level of teacher education has remained unchanged since 1980.[9]

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[6] O'Sullivan, C. Y., Reese, C. M., & Mazzeo, J. (1997). *NAEP 1996 science report card for the nation and the states: Findings from the National Assessment of Educational Progress* (Publication No. NCES 97-499). Washington, DC: National Center for Education Statistics.

[7] Mullis, I. V. S., Jenkins, F., & Johnson, E. G. (1994). *Effective schools in mathematics*. Washington, DC: National Center for Education Statistics.

Raudenbush, S. & Bryk, A. (1986). A hierarchical model for studying school effects. *Sociology of Education, 52*, 1-17.

[8] U.S. Department of Education. National Center for Education Statistics. (1997) *Digest of education statistics, 1997*. Washington, DC: Author.

[9] National Education Association. (1997). *Status of the American public school teacher, 1995-1996*. West Haven, CT.

Fields of Study

It is important for teachers to have a solid base in the subjects they teach. Research shows that if teachers do not feel adequately prepared in a particular subject area, such as science, they may neglect this subject and focus on other academic areas in which they feel more comfortable.[10] This finding would appear to be of particular concern at the fourth-grade level where, according to data collected from principals during the NAEP 1996 science assessment, 57 percent of students were taught in self-contained classrooms and remained with the same teacher for all academic subjects. A further 36 percent were regrouped, that is, students remained with one teacher for most subjects but may have had a different teacher for one or two subjects.[11]

At the eighth-grade level, 82 percent of students attended schools where the eighth grades were departmentalized.[12] Thus students had different teachers for most or all academic subjects. Given the organization of the nation's fourth- and eighth-grade classrooms, it might be expected that more eighth-grade science teachers would hold degrees in science than their colleagues who taught fourth grade. Information collected during the NAEP 1996 science assessment bears out this assumption.

Teachers of students in grades 4 and 8 who participated in the NAEP 1996 science assessment were asked to report on their undergraduate and graduate majors. On the basis of their responses, teachers were placed into one of five mutually exclusive categories.

- **Science**, which includes teachers with an undergraduate or graduate degree in science
- **Science Education**, which includes teachers with an undergraduate or graduate degree in science education, but not in science
- **Education**, which includes teachers with an undergraduate or graduate degree in education, elementary education, or secondary education, but not science or science education
- **Other**, which includes teachers with any major at the undergraduate or graduate levels other than the above
- **Missing/None Indicated**, which includes missing data at the undergraduate and graduate level; teachers who had no graduate-level study and who failed to indicate an undergraduate major; and teacher questionnaires not matched to students

Since teachers also reported on their minor fields of study, a second analysis was conducted combining major and minor degrees at the undergraduate and graduate levels. The same five categories were used to sort the responses.

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[10] Brophy, J. (1991). Advances in research on teaching. (Vol. 2) *Teacher's knowledge of subject matter as it relates to their teaching practice*. Greenwich, CT: JAI Press.

[11] National Center for Education Statistics, National Assessment of Educational Progress (1997). *1996 Science assessment summary data tables* [On-line]. Available: http://nces.ed.gov/naep/tables96/index.shtml.

[12] Ibid.

National Findings

The results are presented in Table 2.2. Seventy-four percent of grade 4 students were taught by teachers who held an undergraduate or graduate major in education. Ten percent were taught by teachers who held a science or a science education degree. This finding is similar to that obtained from the NAEP 1996 mathematics assessment, in which 83 percent of fourth-grade students were taught mathematics by teachers who had an undergraduate or graduate major in education.[13] At the eighth grade, 45 percent of students were taught science by teachers who reported having an undergraduate or graduate major in science. Another 11 percent of students were taught by teachers who held a science education degree. Again this is similar to results found in the NAEP 1996 mathematics assessment, where 49 percent of eighth-grade students were taught mathematics by teachers who held a degree in mathematics at either the undergraduate or graduate level.[14]

When minor fields of study were included at the undergraduate and graduate level, the percentage of grade 4 students taught by teachers with a science or science education degree increased from 10 to 16 percent. At the eighth-grade level, 52 percent of students were taught by teachers who had a major or minor in science, compared to 45 percent who were taught by teachers with a science major. A few associations were found between the performance of students and their teachers' undergraduate or graduate field of study. Fourth-grade students whose teachers held a major in education had higher scale scores than students whose teachers held a major other than science or science education. In addition, students whose teachers had a major or minor in science education had higher scale scores than both students whose teachers indicated holding an "other" major or minor and students whose teachers were in the missing or none indicated category. Achievement-level data show that the percentage of fourth-grade students performing at or above *Proficient* was greater for those whose teachers indicated an education major than for those whose teachers indicated an "other" major or were in the missing/none indicated category. In addition, the percentage performing at or above *Proficient* was higher for students whose teachers had a major or minor in science education than for those whose teachers indicated an "other" major or minor or were in the missing/none indicated category. Finally, the percentage performing at or above *Proficient* was higher for students whose teachers had a major or minor in education than for those whose teachers were in the missing/none indicated category.

At the eighth-grade level, students whose teachers majored in science had higher scale scores than students whose teachers were in the missing/none indicated category. Students whose teachers majored or minored in science had higher scale scores than their counterparts whose teachers majored or minored in science education and students whose teachers were in the missing/none indicated category. The percentage of eighth-grade students who reached the *Proficient* level was higher for those students whose teachers reported a major or major/minor in science than for those whose teachers were in the missing/none indicated category.

In summary, at least 80 percent of the nation's fourth graders and 28 percent of the nation's eighth graders were taught science by teachers who did not have an undergraduate or graduate degree in science or science education. While fourth-grade teachers might not be

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[13] Hawkins, E.F., Stancavage, F., & Dossey, J. (in press). *School policies affecting instruction in mathematics: Findings from the National Assessment of Educational Progress*. Washington, DC: National Center for Education Statistics.

[14] Ibid.

TABLE 2.2 Teachers' Reports on Their Undergraduate or Graduate Fields of Study: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

What were your fields of study?	Grade 4		Grade 8	
	Major	**Major or Minor**	**Major**	**Major or Minor**
Science				
Percentage of Students	5	8	45	52
Average Scale Score	144	151	154	154
Percentage At or Above *Proficient*	29	35	33	33
Science Education but not Science				
Percentage of Students	5	8	11	10
Average Scale Score	151	156	148	144
Percentage At or Above *Proficient*	26	34	27	25
Education but not Science or Science Education				
Percentage of Students	74	69	20	18
Average Scale Score	152	151	149	149
Percentage At or Above *Proficient*	31	30	28	28
Other				
Percentage of Students	6	5	8	3
Average Scale Score	140	139	150	149
Percentage At or Above *Proficient*	18	18	27	29
Missing/None Indicated				
Percentage of Students	9	9	17	17
Average Scale Score	142	142	142	142
Percentage At or Above *Proficient*	20	20	21	21

NOTE: Numbers may not add up to 100 due to rounding.

This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details. The missing/none category includes missing data at the undergraduate and graduate levels; teachers who had no graduate level study and who failed to indicate an undergraduate major; and teacher questionnaires not matched to students.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

expected to have a science degree, the lack of an academic concentration in science by fourth- and eighth-grade teachers may be of some concern since research has shown that without the essential base of subject matter knowledge, teachers may be unable to instruct effectively.[15] Moreover, research has shown that if teachers possess both subject matter expertise and the ability to present that subject matter to students, they are more likely to engage in activities that facilitate student learning.[16]

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[15] Grossman, P. L., Wilson, S.M., & Shulman, L.S., Teachers of substance, subject matter knowledge for teaching. In M. Reynolds (Ed.), *Knowledge base for the beginning teacher*, pp. 23-36. New York: Pergamon.

Lee, O. (1995). Subject matter knowledge, classroom management, and instructional practices in science middle school classrooms. *Journal of research in science teaching*, *32* (4) 423-440.

[16] Tobin, K. & Fraser, B. (1990). What does it mean to be an exemplary science teacher? *Journal of research in science teaching*, *27* (1), pp. 3-25.

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Jurisdiction Findings

Eighth-grade teachers whose students participated in state NAEP were also asked to report their undergraduate and graduate majors. The public school results for the nation and for the jurisdictions are shown alphabetically in Table 2.3. The five categories in the table are mutually exclusive and therefore give some indication of the percentages of students whose teachers had majors in science or no majors in science. For example, between 4 and 42 percent of students were taught by teachers who held an education degree but not a science or science education degree. Similarly, teachers of between 4 and 35 percent of students held a science education degree but no science degree.

A recent survey of state education departments shows that some states are now requiring new teachers to have an undergraduate degree with a major in their field of teaching rather than in general education. This new requirement reflects the desire by states that teachers have subject matter expertise in the areas in which they teach. According to the survey data, 10 states have an explicit requirement that all new teachers have a major in a specific subject field. An additional 22 states confine the requirement to new secondary school teachers.[17]

Several jurisdictions show a high percentage of students with teachers in the missing/ none category. These percentages largely reflect the relatively low number of students matched to science teacher questionnaires in those jurisdictions. For example, in Hawaii 59 percent of students were taught by teachers in the missing/none category and forty-one percent of students were matched to science teacher questionnaires. By comparison, in Arkansas, where ninety-six percent of Arkansas students were matched to science teacher questionnaires, five percent of students had teachers in the missing/none category.[18]

Figure 2.1 presents the percentages of eighth-grade public school students whose teachers had an undergraduate or graduate major in science. The jurisdictions are divided into three groups: states where the percentages were greater than that for the nation; states where the percentages did not differ significantly from that for the nation; and states where the percentages were lower than that for the nation. The figure reveals that in 28 jurisdictions the percentage of eighth-grade public school students whose teachers had undergraduate or graduate science majors was not significantly different from the percentage for the nation (47 percent). Twelve jurisdictions had percentages greater than for the nation, ranging from 60 to 74 percent. Four jurisdictions had percentages below the nation's: DDESS, Georgia, Hawaii, and Louisiana had between 25 and 36 percent of eighth-grade public school students in classrooms with teachers who had majored in science at the undergraduate or graduate level.

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[17] Council of Chief State School Officers. (1996). *Key state education policies on K-12 education: Content standards, graduation, teacher licensure, time and attendance.* Washington, DC: Council of Chief State School Officers, State Education Assessment Center.

[18] Data on the weighted percentage of students matched to science teacher questionnaires can be found in Allen, N.L., Swinton, S.S., Isham, S.P., & Zelenak, C.A. (1997). *Technical report of the NAEP 1996 state assessment program in science.* Washington, DC: National Center for Education Statistics.

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TABLE 2.3

Teachers' Reports on Their Undergraduate or Graduate Fields of Study, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

What were your fields of study?	Science	Science Education but not Science	Education but not Science or Science Ed.	Other	Missing/ None Indicated	Total % At or Above *Proficient*
Grade 8	Percentage of Students					
Nation	47	12	16	8	17	27
Alabama	57	14	20	2	8	18
Alaska[a]	53	5	12	5	24	31
Arizona	44	14	29	3	10	23
Arkansas[a]	48	17	25	6	5	22
California	61	4	20	5	10	20
Colorado	66	7	10	4	14	32
Connecticut	51	15	19	3	12	36
Delaware	60	9	18	3	11	21
DDESS	36	35	16	0	12	27
DoDDS	65	4	17	4	10	31
District of Columbia	40	14	7	4	35	5
Florida	42	17	17	8	16	21
Georgia	28	22	36	5	10	21
Guam	48	26	6	0	19	7
Hawaii	28	4	6	3	59	15
Indiana	51	16	17	4	11	30
Iowa[a]	58	13	22	0	6	36
Kentucky	43	13	26	1	16	23
Louisiana	25	15	42	6	12	13
Maine	45	17	24	1	13	41
Maryland[a]	63	9	12	7	10	25
Massachusetts	55	12	17	5	12	37
Michigan[a]	47	20	18	2	12	32
Minnesota	74	10	6	1	9	37
Mississippi	36	15	33	5	11	12
Missouri	54	13	18	3	12	28
Montana[a]	63	6	17	4	10	41
Nebraska	58	23	9	0	11	35
New Mexico	46	11	23	5	15	19
New York[a]	68	4	6	4	17	27
North Carolina	37	27	22	5	9	24
North Dakota	57	21	13	4	5	41
Oregon	56	14	15	2	13	32
Rhode Island	64	12	15	3	6	26
South Carolina[a]	38	19	25	7	10	17
Tennessee	37	11	39	5	9	22
Texas	58	15	10	9	9	23
Utah	70	6	7	3	13	32
Vermont[a]	60	17	12	2	9	34
Virginia	54	13	18	8	7	27
Washington	53	5	16	4	22	27
West Virginia	51	25	13	1	9	21
Wisconsin[a]	42	5	34	1	18	39
Wyoming	73	8	4	1	14	34

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

NOTE: Numbers may not add up to 100 due to rounding.

This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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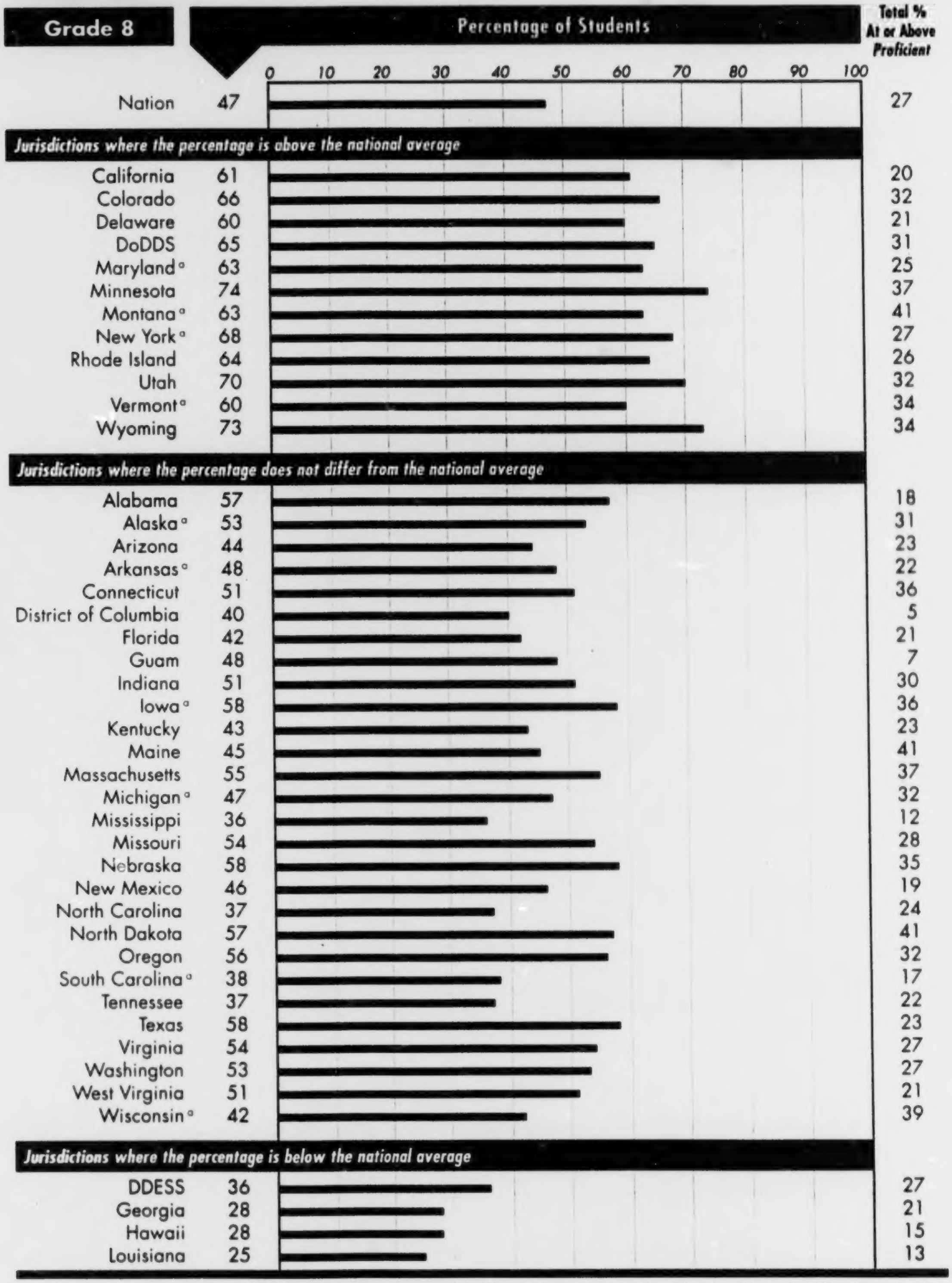
FIGURE 2.1

Teachers' Reports on Their Undergraduate or Graduate Major in Science, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep



Grade 8	Percentage of Students	Total % At or Above Proficient
Nation	47	27
Jurisdictions where the percentage is above the national average		
California	61	20
Colorado	66	32
Delaware	60	21
DoDDS	65	31
Maryland[a]	63	25
Minnesota	74	37
Montana[a]	63	41
New York[a]	68	27
Rhode Island	64	26
Utah	70	32
Vermont[a]	60	34
Wyoming	73	34
Jurisdictions where the percentage does not differ from the national average		
Alabama	57	18
Alaska[a]	53	31
Arizona	44	23
Arkansas[a]	48	22
Connecticut	51	36
District of Columbia	40	5
Florida	42	21
Guam	48	7
Indiana	51	30
Iowa[a]	58	36
Kentucky	43	23
Maine	45	41
Massachusetts	55	37
Michigan[a]	47	32
Mississippi	36	12
Missouri	54	28
Nebraska	58	35
New Mexico	46	19
North Carolina	37	24
North Dakota	57	41
Oregon	56	32
South Carolina[a]	38	17
Tennessee	37	22
Texas	58	23
Virginia	54	27
Washington	53	27
West Virginia	51	21
Wisconsin[a]	42	39
Jurisdictions where the percentage is below the national average		
DDESS	36	27
Georgia	28	21
Hawaii	28	15
Louisiana	25	13

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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Type and Subject Area of Teaching Certification

The present and future availability of science teachers with the appropriate level and type of teacher certification is affected by a number of factors. First, according to information released by the National Center for Education Statistics, is the growing population of school children in elementary and secondary education, which has increased from approximately 46 million in 1980 to about 50 million in 1995 and is projected to reach almost 54 million in the year 2000.[19] Second is the aging population of public school teachers. In 1996 about 46 percent of public school teachers had more than 20 years teaching experience; thus, many will be retiring over the next 10 years.[20] Third, policies such as class-size reduction have had and may continue to have an impact on the demand for qualified teachers.[21] For example, the California Department of Education has estimated that, in order to fully implement a class-size reduction program in grades K-3, an additional 20,000 classrooms — and a proportionate number of new teachers — will be needed in the next three to five years.[22] Since all of these factors will impact the nation's schools over the next decade, it is useful to evaluate the current status of teacher certification and determine whether the increasing school population, coupled with smaller class size and teacher attrition have already contributed to a shortage of qualified teachers.

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[19] U.S. Department of Education. (1997). National Center for Education Statistics. Office of Educational Research and Improvement. *Digest of education statistics 1997*. Washington, DC: Author.

[20] National Education Association. (1997). *Status of the American public school teacher, 1995-1996*. West Haven, CT: Author.

Data from the NAEP 1996 science assessment showed that nearly one-fifth of students at grades 4 and 8 were taught science by teachers with 25 or more years of experience.

[21] President's State of the Union Address (January 27, 1998) reproduced in *The New York Times*, January 28, 1998.

[22] Source: California Department of Education (1997).

Type of Certification

Information concerning the status of teaching certification in America's public schools is presented in Table 2.4. Teachers of fourth and eighth graders participating in NAEP were asked what type of teaching certificate they held in their main assignment field, that is, the area in which they do most of their teaching.[23] The majority of public school students at both grades 4 and 8 (95 percent and 92 percent, respectively) were taught by teachers who were certified in their main assignment field. The rest of the students were taught by teachers who held temporary, provisional, or emergency certification, or no certification. There was no correlation between student scale scores or the percentage of students at or above *Proficient* and the type of teaching certificate their teachers held.

TABLE 2.4 ***Teachers' Reports on Type of Teaching Certificate Held in Main Assignment Field: Public Schools Only***

THE NATION'S REPORT CARD naep

What type of teaching certificate do you have in this state in your main assignment field?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
Certified		
Percentage of Students	95	92
Average Scale Score	150	151
Percentage At or Above *Proficient*	28	30
Temporary, Provisional, or Emergency Certification		
Percentage of Students	5	7
Average Scale Score	141	146
Percentage At or Above *Proficient*	22	26
None		
Percentage of Students	0	1
Average Scale Score	—	—
Percentage At or Above *Proficient*	—	—

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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[23] It should be noted that data collected by NAEP do not indicate whether students were taught science by teachers whose main assignment field was in fact science. It is likely that elementary education was the main assignment field for most fourth-grade teachers and that science was the main assignment field for most eighth-grade teachers.

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The results regarding type of teacher certification for the nation and for the jurisdictions are shown in Table 2.5. The percentage of public school eighth-grade students taught by teachers who were certified ranged from 74 percent in Michigan to 100 percent in Guam. Twenty-five jurisdictions had percentages greater than 90 and 11 jurisdictions had percentages between 85 and 90. The percentage of students taught by teachers who were certified ranged from 74 to 83 percent for the remaining eight jurisdictions.

The percentage of students taught by teachers holding temporary, provisional, or emergency certification ranged from 0 for Alabama and Guam to 23 for Michigan. In 17 jurisdictions the percentage was between 10 and 23. The percentage of students having teachers with no certification in their main assignment area ranged from zero to nine.

TABLE 2.5 Teachers' Reports on Type of Teaching Certificate Held in Main Assignment Field, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

What type of teaching certificate do you have in this state in your main assignment field?	Certified	Temporary, Provisional, or Emergency Certification	None	Total % At or Above *Proficient*
Grade 8	**Percentage of Students**			
Nation	92	7	1	27
Alabama	99	0	1	18
Alaska[a]	97	2	1	31
Arizona	85	12	3	23
Arkansas[a]	97	1	2	22
California	82	15	3	20
Colorado	87	12	2	32
Connecticut	86	12	2	36
Delaware	86	12	2	21
DDESS	85	6	9	27
DoDDS	98	1	1	31
District of Columbia	94	6	0	5
Florida	82	17	1	21
Georgia	97	3	0	21
Guam	100	0	0	7
Hawaii	78	18	4	15
Indiana	96	4	1	30
Iowa[a]	94	5	1	36
Kentucky	91	9	0	23
Louisiana	82	16	3	13
Maine	87	13	0	41
Maryland[a]	89	11	0	25
Massachusetts	93	2	5	37
Michigan[a]	74	23	3	32
Minnesota	95	5	0	37
Mississippi	91	8	1	12
Missouri	88	12	0	28
Montana[a]	91	9	0	41
Nebraska	93	7	0	35
New Mexico	95	4	1	19
New York[a]	83	15	1	27
North Carolina	86	13	1	24
North Dakota	98	2	1	41
Oregon	90	7	3	32
Rhode Island	81	19	0	26
South Carolina[a]	92	6	2	17
Tennessee	93	7	0	22
Texas	90	10	1	23
Utah	81	18	1	32
Vermont[a]	93	7	0	34
Virginia	94	5	1	27
Washington	93	7	0	27
West Virginia	94	5	1	21
Wisconsin[a]	99	1	0	39
Wyoming	97	3	0	34

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Area of Certification

Teachers were also asked in what areas they held teaching certificates. For the purposes of this report the areas were classified into three mutually exclusive certification categories.

- **Science,** which includes teaching certificates in elementary science or in middle/junior high or secondary science.
- **Education,** which includes teaching certificates in elementary/middle school education but not in elementary science or middle/ junior high or secondary science.
- **Other,** which includes teaching certificates in a field other than those included in the science or education categories.

These data for public schools only, are presented in Table 2.6. Since the areas of teaching certification and the prerequisites for teacher certification vary from state to state, the categories presented to teachers were rather broad and in no way indicate what was required for a teacher to become certified in a particular area. The NAEP results reveal that 27 percent of grade 4 public school students were taught by teachers who reported holding teaching certification in science. But, given that 16 percent of students were taught by teachers who reported a major or minor in science or science education (Table 2.2), it would appear that some states do not require a major or minor in science or science education for science certification.

TABLE 2.6

Teachers' Reports on the Subject Area Covered by Teaching Certificate: Public Schools Only

THE NATION'S REPORT CARD naep

Do you have a teaching certificate in any of the following areas that is recognized by the state in which you teach?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students Whose Teachers Responded Yes	
Science		
Percentage of Students	27	72
Average Scale Score	151	151
Percentage At or Above *Proficient*	29	30
Education, but not Science		
Percentage of Students	62	9
Average Scale Score	149	144
Percentage At or Above *Proficient*	28	24
Other		
Percentage of Students	1	1
Average Scale Score	—	132
Percentage At or Above *Proficient*	—	13

NOTE: This table contains information obtained from three derived variables. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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Evidence to support this assertion can be found in outside sources as well. The National Science Teachers Association (NSTA) standards for teacher certification require candidates for elementary science certification to complete 12 semester hours in a laboratory or field-oriented science, including courses in biology, physical science, and earth and space science, and to complete an elementary science methods course or the equivalent. The NSTA standards have been adopted by the National Council for the Accreditation of Teacher Education and by the Association for the Education of Teachers of Science. Individual state requirements may not even be as stringent as the NSTA's, as seen in the National Association of State Directors of Teacher Education and Certification *Manual on the Preparation and Certification of Educational Personnel.* For example, Louisiana requires 15 semester hours of science for elementary certification, but Arizona requires 8 hours, and Texas requires 3 hours. None of these requirements would necessitate a science major for fulfillment.[24] Scale scores and achievement level data for grade 4 show no significant differences in performance for students whose teachers responded "yes" to each category compared to those whose teachers responded "no."

In eighth grade, 72 percent of public school students were taught by teachers who reported holding teaching certification in science. Sixty-two percent of students were taught by teachers who reported having a major or minor in science or science education (Table 2.2). At the middle school level, NSTA certification in science requires 24 semester hours in a biological or life science, earth and space science, and physical science (physics and chemistry) as well as completion of a science methods course or equivalent designed specifically for middle school teachers.[25] As part of the NAEP 1990 science assessment, teachers were also asked about their area of certification.[26] Those data show that teachers of 80 percent of eighth graders indicated that they held teaching certification in the area of science. Eighth-grade students whose teachers were certified in science had higher scale scores than students whose teachers were not certified in science. Similar results were found for the achievement level data. Furthermore, the percentage of students at or above *Proficient* was lower for those whose teachers responded "yes" to being certified in an area other than science or science education.

The results regarding subject area of teacher certification for the nation and for the jurisdictions are shown in Table 2.7. The percentage of public school eighth-grade students taught by teachers who were certified in science ranged from 31 percent in Hawaii to 91 percent in Rhode Island. The percentage of students taught by teachers holding certification in general education ranged from 1 percent for DoDDS and Minnesota to 46 percent for Georgia. No more than 6 percent of students in any jurisdiction had teachers certified in an area other than science or education.

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[24] National Science Teachers Association. (1992). *NSTA teacher certification requirements* Arlington, VA: Author.
National Association of State Directors of Teacher Education and Certification. (1998). *The NASDTEC manual on the preparation and certification of educational personnel, 1998-1999.* (4th Ed.). Dubuque, IA: Kendall/Hunt Publishing Co.

[25] National Science Teachers Association. (1992). *NSTA teacher certification requirements* Arlington, VA: Author.

[26] Jones, L. R., Mullis, I. V. S., Raizen, S. A., Weiss, I. R., & Weston, E. A. (1992). *The 1990 science report card.* Washington, DC: National Center for Education Statistics.

TABLE 2.7

Teachers' Reports on the Subject Area Covered by Teaching Certificate, for the Nation and Jurisdictions: Public Schools Only

Do you have a teaching certificate in any of the following areas that is recognized by the state in which you teach?	**Area of Certification**			
	Science	**Education, But Not Science**	**Other**	**Total % At or Above *Proficient***
Grade 8	**Percentage of Students Whose Teachers Responded Yes**			
Nation	72	9	1	27
Alabama	79	9	1	18
Alaska [a]	55	14	5	31
Arizona	53	34	2	23
Arkansas [a]	88	3	2	22
California	73	12	2	20
Colorado	71	11	3	32
Connecticut	59	27	0	36
Delaware	72	14	1	21
DDESS	72	16	0	27
DoDDS	88	1	1	31
District of Columbia	59	5	0	5
Florida	71	5	4	21
Georgia	43	46	2	21
Guam	69	12	0	7
Hawaii	31	4	1	15
Indiana	80	6	0	30
Iowa [a]	83	8	2	36
Kentucky	61	21	2	23
Louisiana	43	32	6	13
Maine	59	28	0	41
Maryland [a]	71	12	2	25
Massachusetts	73	11	2	37
Michigan [a]	71	12	1	32
Minnesota	88	1	0	37
Mississippi	62	24	1	12
Missouri	79	6	1	28
Montana [a]	69	18	0	41
Nebraska	78	7	1	35
New Mexico	66	14	2	19
New York [a]	74	5	1	27
North Carolina	73	11	2	24
North Dakota	84	8	0	41
Oregon	67	17	1	32
Rhode Island	91	2	0	26
South Carolina [a]	63	22	3	17
Tennessee	70	20	1	22
Texas	81	4	1	23
Utah	79	5	1	32
Vermont [a]	84	4	1	34
Virginia	79	11	1	27
Washington	63	15	0	27
West Virginia	83	8	0	21
Wisconsin [a]	61	20	0	39
Wyoming	80	4	1	34

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

NOTE: This table contains information obtained from three derived variables. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Years of Teaching Experience

According to data from a survey conducted by the NEA, the 1995-1996 public school teaching staff (K-12) was the most experienced since the survey was first administered in 1960.[27] Teachers had an average of 16 years full-time experience, with 46 percent having entered teaching more than 20 years earlier. Similar data were sought in the NAEP 1996 science assessment, in which teachers of fourth and eighth graders were asked to indicate the number of years they had taught science. While results cannot be directly compared with the NEA data, some similar patterns do emerge.

The NAEP data presented in Figure 2.2 are consistent with the NEA data in showing an experienced teaching force. In the fourth and eighth grades, 69 percent and 74 percent of students, respectively, were taught science by teachers who reported having six or more years of science teaching experience. The percentages of students whose teachers reported teaching science for two years or less were 13 and 14 at grades 4 and 8, respectively. Teachers of 48 percent of fourth graders and 45 percent of eighth graders reported having 11 or more years of teaching experience.

At the fourth-grade level student performance was similar regardless of how long their teachers had taught. Some differences in scale scores were seen at the eighth-grade level. Students of teachers who had taught either 6-10 years or 25 or more years had higher scale scores than students whose teachers had five or fewer years of teaching experience. The percentage of eighth-grade students reaching the *Proficient* level did not vary significantly with the number of years their teachers reported teaching science.

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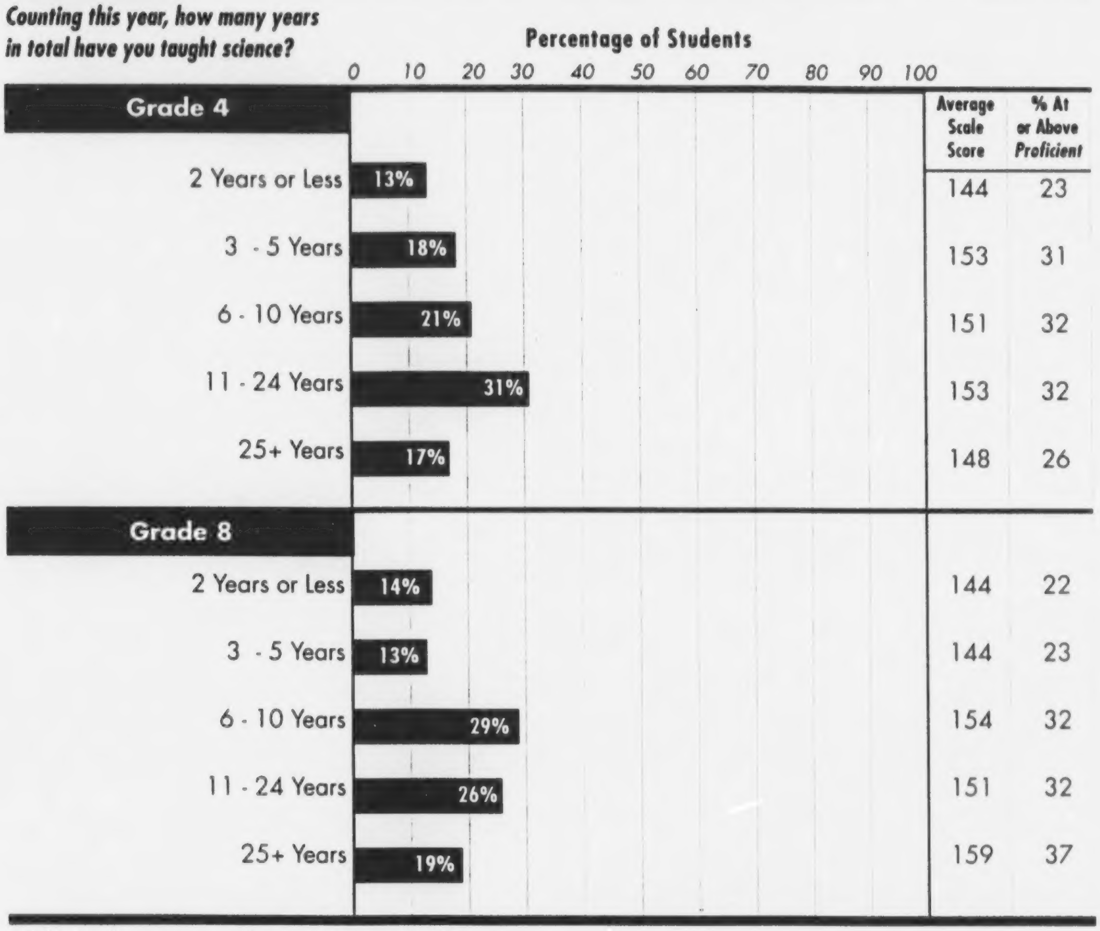
[27] National Education Association. (1997). *Status of the American public school teacher, 1995-1996* West Haven, CT: Author.

FIGURE 2.2

Teachers' Reports on Number of Years Teaching Science: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep



NOTE: Numbers may not add up to 100 due to rounding.
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Teachers' Professional Activities in Sciences

In 1989 the President and the states' governors established eight national education goals.[28] Goal 4 stated: "By the year 2000, the nation's teaching force will have access to programs for the continuing improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to instruct and prepare all American students for the next century."

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[28] National Governors' Association. (1991). *Educating America: State strategies for achieving the national education goals.* Washington, DC: Author.
U.S. Department of Education. (1991). *AMERICA 2000: An education strategy.* Washington, DC: Author.

A subsequent report, sponsored by the National Governors' Association, recognized that systemic reforms placed many demands on teachers, from improving subject matter expertise to becoming familiar with the latest pedagogical research.[29] These systemic reforms have led to an increased appreciation of professional development activities as a means of keeping abreast of changes in content knowledge and pedagogical theories and practices.[30] Some states, such as Kentucky, Minnesota, and Missouri, have already recognized the importance of professional development by increasing investments in such programs.[31]

Although teachers have long been participating in professional development activities — workshops, seminars, in-service courses, etc. — a recent report shows that the percentage of teachers attending such professional development activities has increased in the last 25 years from approximately 59 percent to 77 percent.[32] NAEP gathered data on two aspects of professional development: the extent to which teachers participated in professional development and the types of professional development activities in which they were involved. It could be argued that the quality of these activities is more important than either the types of activities or the number of hours spent engaged in them. However, no data were collected on quality, and NAEP data cannot be used to examine the quality issue.

Time Spent in Professional Development

Teachers whose students participated in the NAEP 1996 science assessment were asked how much time they had spent in professional development during the previous year (1995) at workshops or seminars in science or science education. Teachers were asked to include attendance at professional meetings and conferences, district-sponsored workshops, and external workshops. The results are shown in Table 2.8. The majority of fourth-grade students (62 percent) were taught by teachers who had less than six hours of professional development in science or science education. The finding is not surprising because most fourth-grade teachers must divide their time between several subjects, and when they do participate in professional development, teachers may be more likely to focus on higher priority subjects like mathematics and reading or on non-subject specific issues. Data from the 1996 mathematics assessment support this conjecture. Mathematics teachers of 46 percent of fourth-grade students reported spending less than six hours in professional development.[33] Sixteen percent of fourth-grade students were taught science by teachers who reported having attended 16 or more hours of professional development. In contrast, 27 percent of students were taught mathematics by teachers who reported having had 16 or more hours of professional development in mathematics in the last year.[34]

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[29] Corcoran, T.C. (1995). *Transforming professional development for teachers: A guide for state policymakers.* Washington, DC: National Governors' Association.

[30] Ibid.

[31] Ibid.

[32] National Education Association. (1997). *Status of the American public school teacher, 1995-1996* West Haven, CT: Author. Susan Choy and Xianglei Chen (1998). *Toward better teaching: Professional development in 1993-94.* (Publication No. NCES 98-230). Washington, DC: National Center for Education Statistics.

[33] Hawkins, E.F., Stancavage, F., & Dossey, J. (in press). *School policies affecting instruction in mathematics: Findings from the National Assessment of Educational Progress.* Washington, DC: National Center for Education Statistics.

[34] Ibid.

TABLE 2.8 Teachers' Reports on Amount of Time Spent in Professional Development Workshops or Seminars in Science or Science Education During the Last Year: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

During the last year, how much time in total have you spent in professional development workshops or seminars in science or science education?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
None		
Percentage of Students	30	9
Average Scale Score	151	152
Percentage At or Above *Proficient*	28	27
Less than 6 Hours		
Percentage of Students	32	16
Average Scale Score	151	152
Percentage At or Above *Proficient*	31	33
6 - 15 Hours		
Percentage of Students	22	21
Average Scale Score	151	150
Percentage At or Above *Proficient*	29	31
16 - 35 Hours		
Percentage of Students	9	26
Average Scale Score	155	154
Percentage At or Above *Proficient*	36	33
More than 35 Hours		
Percentage of Students	7	29
Average Scale Score	146	151
Percentage At or Above *Proficient*	26	28

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Since teachers of eighth-grade science tend to teach only science, it is probably not unexpected that 76 percent of students were taught by teachers who spent six or more hours in professional development. This figure is similar to the one collected from mathematics teachers during the NAEP 1996 mathematics assessment. Teachers of 74 percent of eighth-grade students reported spending six hours or more in professional development in mathematics or mathematics education.[35] An analysis of scale scores and percentage at or above *Proficient* of fourth- and eighth-grade students revealed that student performance in science did not vary with the amount of time their teachers spent in science-related professional development workshops or seminars.

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[35] Hawkins, E.F., Stancavage, F., & Dossey, J. (in press). *School policies affecting instruction in mathematics: Findings from the National Assessment of Educational Progress*. Washington, DC: National Center for Education Statistics.

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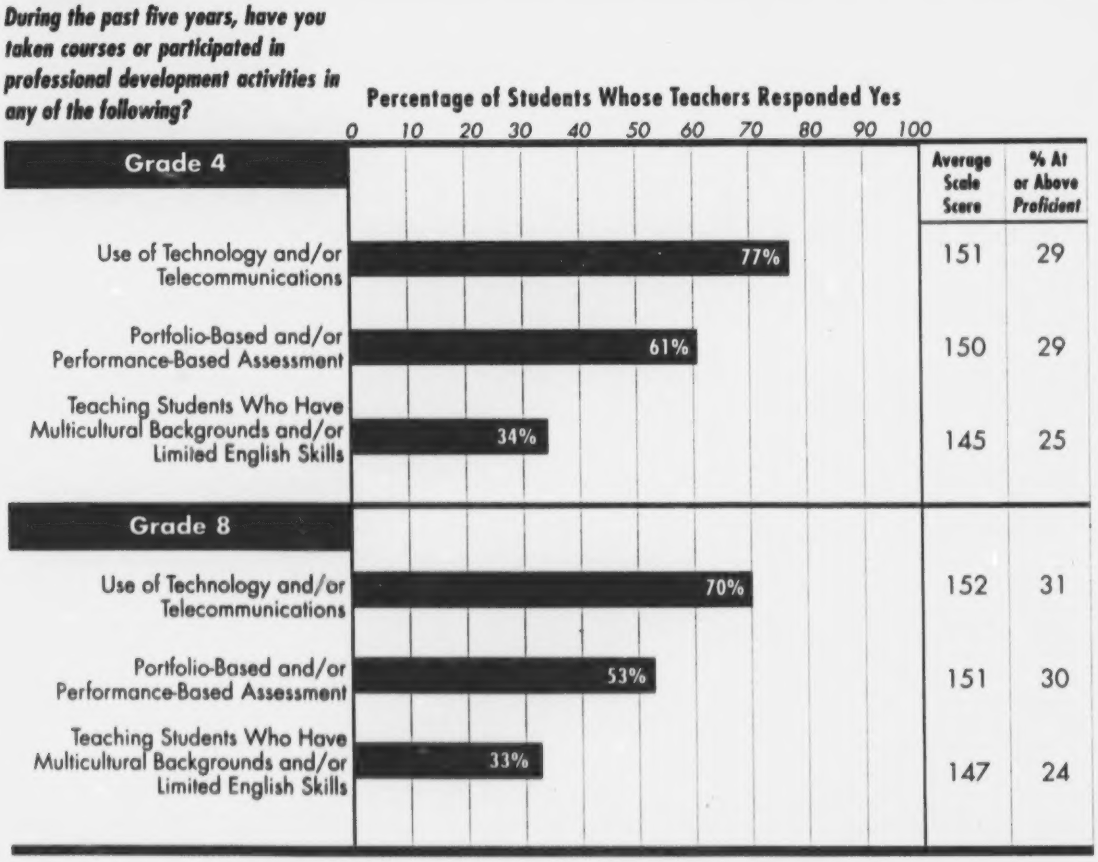
Types of Professional Development

The types of professional development activities undertaken by teachers may provide an indication of what teachers, schools, and districts consider important in science education. Figure 2.3 shows the national data for the percentages of public and nonpublic school students taught by teachers who had the opportunity to stay abreast of current thinking in three areas of education. Figures 2.4 to 2.6 show the percentages of eighth-grade public school students for the nation and jurisdictions whose teachers participated in the same three areas of professional development activities. The information presented in the figures is discussed in the following three sections.

FIGURE 2.3 **Teachers' Reports on Professional Development Activities Over the Last Five Years: Public and Nonpublic Schools Combined**



NOTE: Numbers may not add up to 100 due to rounding.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Use of Technology and Telecommunications

Goal 1 of President Clinton's National Technology Literacy Challenge states that "All teachers in the nation will have the training and support they need to help students learn using computers and the information highway."[36] About two-thirds of schools are now connected to the Internet, and students have increasing opportunities to use computers to access, retrieve, organize, and store data using hardware and software designed for these purposes.[37] Yet, a study of teachers and the effective use of technology in schools conducted by the United States Office of Technology in 1995 found that teachers have not had suitable training to prepare them to use technology in their teaching.[38] The data collected in NAEP indicate the percentage of students taught by teachers who have undergone training in the use of telecommunications and/or technology such as computers. The data do not, however, reveal the extent or the quality of this training or what facilities were in place in the various school districts to augment and support the training.

As shown in Figure 2.3, 77 percent of grade 4 students and 70 percent of grade 8 students were taught by teachers who had some professional development activity in the use of technology and/or telecommunications. These figures are likely to increase, given national and state policies. An examination of student performance at grade 4 showed no differences in scale scores or percentage of students at or above *Proficient*. Eighth-grade students whose teachers had professional development in the use of technology and/or telecommunications had higher scale scores than students whose teachers did not have professional development in these areas. No difference was seen in achievement level results.

As of 1996, 32 states required courses in educational technology for teaching licensure.[39]As seen in Figure 2.4, most jurisdictions had student percentages that did not differ significantly from the national percentage (71 percent) for public school students. They ranged from 64 percent to 82 percent. Two jurisdictions had a larger percentage than the nation — DDESS and DoDDS (Department of Defense domestic and overseas schools) — and three jurisdictions had a smaller percentage than the nation — District of Columbia, Hawaii, and Louisiana.

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[36] Executive Office of the President. (1996). *National technology literacy goals.* Washington, DC: U.S. Government Printing Office.

[37] Coley, R.J., Cradler, J., & Engel, P.K. (1997). *Computers and classrooms: The status of technology in U.S. schools.* Princeton, NJ: Policy Information Center, Educational Testing Service.

National Center for Education Statistics. (1997). *Advanced telecommunications in U.S. public elementary and secondary schools, Fall 1996* (Publication No. NCES 97-944). Washington, DC: Department of Education, Office of Educational Research and Improvement.

[38] U.S. Congress, Office of Technology Assessment. (1995). *Teachers and technology: Making the connection* (OTA-HER-616). Washington, DC: U.S. Government Printing Office.

[39] *Quality counts: A report card on the condition of public education in the 50 states.* (1997, January 22). *Education Week.*

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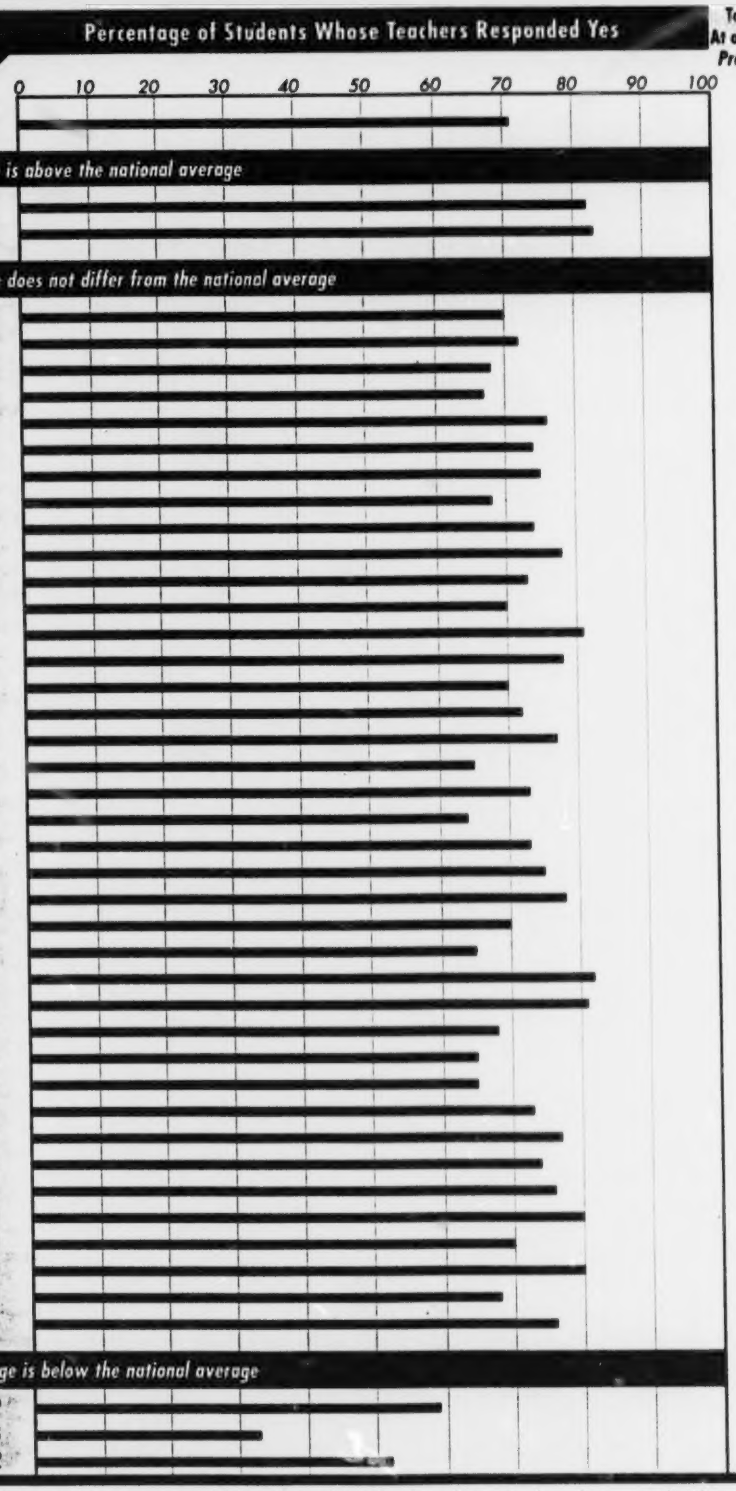
FIGURE 2.4

Teachers' Reports on Professional Development Activities Over the Last Five Years in Use of Technology and/or Telecommunications, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD

Grade 8



	Percentage of Students Whose Teachers Responded Yes	Total % At or Above Proficient
Nation	71	27
Jurisdictions where the percentage is above the national average		
DDESS	82	27
DoDDS	83	31
Jurisdictions where the percentage does not differ from the national average		
Alabama	70	18
Alaska°	72	31
Arizona	68	23
Arkansas°	67	22
California	76	20
Colorado	74	32
Connecticut	75	36
Delaware	68	21
Florida	74	21
Georgia	78	21
Guam	73	7
Indiana	70	30
Iowa°	81	36
Kentucky	78	23
Maine	70	41
Maryland°	72	25
Massachusetts	77	37
Michigan°	65	32
Minnesota	73	37
Mississippi	64	12
Missouri	73	28
Montana°	75	41
Nebraska	78	35
New Mexico	70	19
New York°	65	27
North Carolina	82	24
North Dakota	81	41
Oregon	68	32
Rhode Island	65	26
South Carolina°	65	17
Tennessee	73	22
Texas	77	23
Utah	74	32
Vermont°	76	34
Virginia	80	27
Washington	70	27
West Virginia	80	21
Wisconsin°	68	39
Wyoming	76	34
Jurisdictions where the percentage is below the national average		
District of Columbia	59	5
Hawaii	33	15
Louisiana	52	13

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Portfolio-Based and Performance-Based Assessment

Research over the last decade has suggested that assessments that utilize authentic situations measure what students know and can do more accurately than traditional assessments.[10] A number of schools and states have developed authentic assessments, such as portfolio-based assessments and performance-based assessments. Vermont has developed student portfolios in writing, and other states, including New York, are using hands-on tasks as part of their current assessments.[11] Given the interest in authentic assessment, it is probably not surprising to discover that 61 percent of students at the fourth-grade level and 53 percent of students at the eighth-grade level had teachers who reported having undergone some training in these methodologies (Figure 2.3). An examination of scale scores and achievement level data of fourth- and eighth-grade students showed that student performance did not vary by whether their teachers had professional development experience in portfolio-based or performance-based assessment.

Among the jurisdictions, Kentucky alone had a significantly larger percentage than the national percentage of grade 8 public school students who were taught by teachers who had training in authentic assessments. In eight jurisdictions the percentage was lower than for the nation (Figure 2.5).

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[10] Darling-Hammond, L., Ancess, J., & Falk, B. (1995). *Authentic assessment in action: Studies of schools and students at work.* New York, NY: Columbia University, Teachers College.

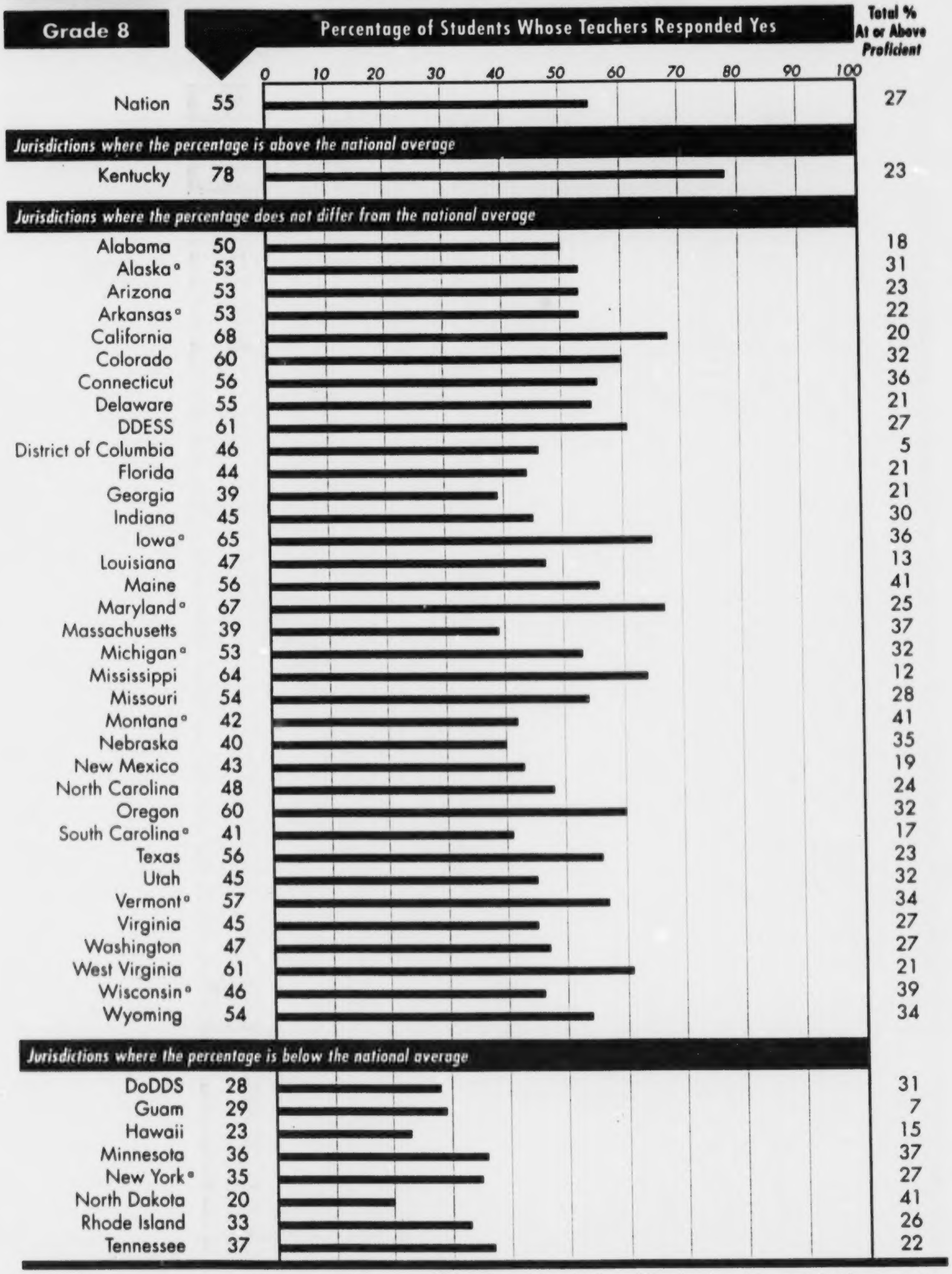
Wiggins, G. (1989). Teaching to the (authentic) test. *Educational Leadership, 46* (7), 141-147.

[11] Darling-Hammond, L., Ancess, J., & Falk, B. (1995). *Authentic assessment in action: Studies of schools and students at work.* New York, NY: Columbia University, Teachers College.

THE NATION'S REPORT CARD naep

FIGURE 2.5

Teachers' Reports on Professional Development Activities Over the Last Five Years in Portfolio-Based and/or Performance-Based Assessments, for the Nation and Jurisdictions: Public Schools Only



Grade 8	Percentage of Students Whose Teachers Responded Yes	Total % At or Above Proficient
Nation	55	27
Jurisdictions where the percentage is above the national average		
Kentucky	78	23
Jurisdictions where the percentage does not differ from the national average		
Alabama	50	18
Alaska[a]	53	31
Arizona	53	23
Arkansas[a]	53	22
California	68	20
Colorado	60	32
Connecticut	56	36
Delaware	55	21
DDESS	61	27
District of Columbia	46	5
Florida	44	21
Georgia	39	21
Indiana	45	30
Iowa[a]	65	36
Louisiana	47	13
Maine	56	41
Maryland[a]	67	25
Massachusetts	39	37
Michigan[a]	53	32
Mississippi	64	12
Missouri	54	28
Montana[a]	42	41
Nebraska	40	35
New Mexico	43	19
North Carolina	48	24
Oregon	60	32
South Carolina[a]	41	17
Texas	56	23
Utah	45	32
Vermont[a]	57	34
Virginia	45	27
Washington	47	27
West Virginia	61	21
Wisconsin[a]	46	39
Wyoming	54	34
Jurisdictions where the percentage is below the national average		
DoDDS	28	31
Guam	29	7
Hawaii	23	15
Minnesota	36	37
New York[a]	35	27
North Dakota	20	41
Rhode Island	33	26
Tennessee	37	22

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Teaching Students from Different Cultural Backgrounds and Students with Limited English Proficiency

Given the culturally diverse population in the United States, it has become increasingly important that teachers be familiar with the latest research on how to teach students who come from various cultural backgrounds or who have limited English skills.[12] Many school districts, particularly in urban areas, have student populations that are more than 50 percent ethnic minorities, and this percentage is increasing.[13] It is important to note, therefore, that about one-third of students in both grades 4 and 8 had teachers whose professional development included activities related to teaching students with multicultural backgrounds or limited English skills (Figure 2.3). It is also relevant that teachers in some jurisdictions where there are large immigrant populations were more likely to have undertaken such professional development activities than were their colleagues in jurisdictions where there are fewer immigrants (Figure 2.6). In California, Florida, Guam, Nebraska, New Mexico, and Texas, a higher percentage of public school students had teachers who reported professional development work in multicultural and/or limited-English-proficiency education than did students in the nation as a whole. Twenty jurisdictions did not differ significantly from the national percentage. A total of 18 jurisdictions were below the national percentage in this area. Students whose teachers had professional development in teaching students from different cultural backgrounds and/or students with limited English proficiency had lower scale scores at both the fourth- and eighth-grade levels than students whose teachers did not have professional development in these areas. Similar results were seen for the percentage of students at or above *Proficient*. It should be noted that teachers who attend such workshops may be more likely to teach students who might be expected to have lower scale scores because of their limited English skills.

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[12] Barba, R.H. & Bowers, R. S. (1993). *Multicultural infusion: A culturally affirming strategy for science teacher preparation.* Annual meeting of the national association for research in science teaching. Atlanta, GA.

Rubba, P. A., Campbell, L. M., & Dana, T. M. (Eds.). (1993). *Excellence in educating teachers of science.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. pp. 89-90.

[13] California Department of Education. (1986). *Beyond language: Social and cultural factors in schooling language minority students.* Los Angeles, CA: California State University, Bilingual Education Office, Evaluation, Dissemination, and Assessment Center.

U.S. Department of Education, National Center for Education Statistics. (1997). *Digest of education statistics, 1997.* Washington, DC: Author.

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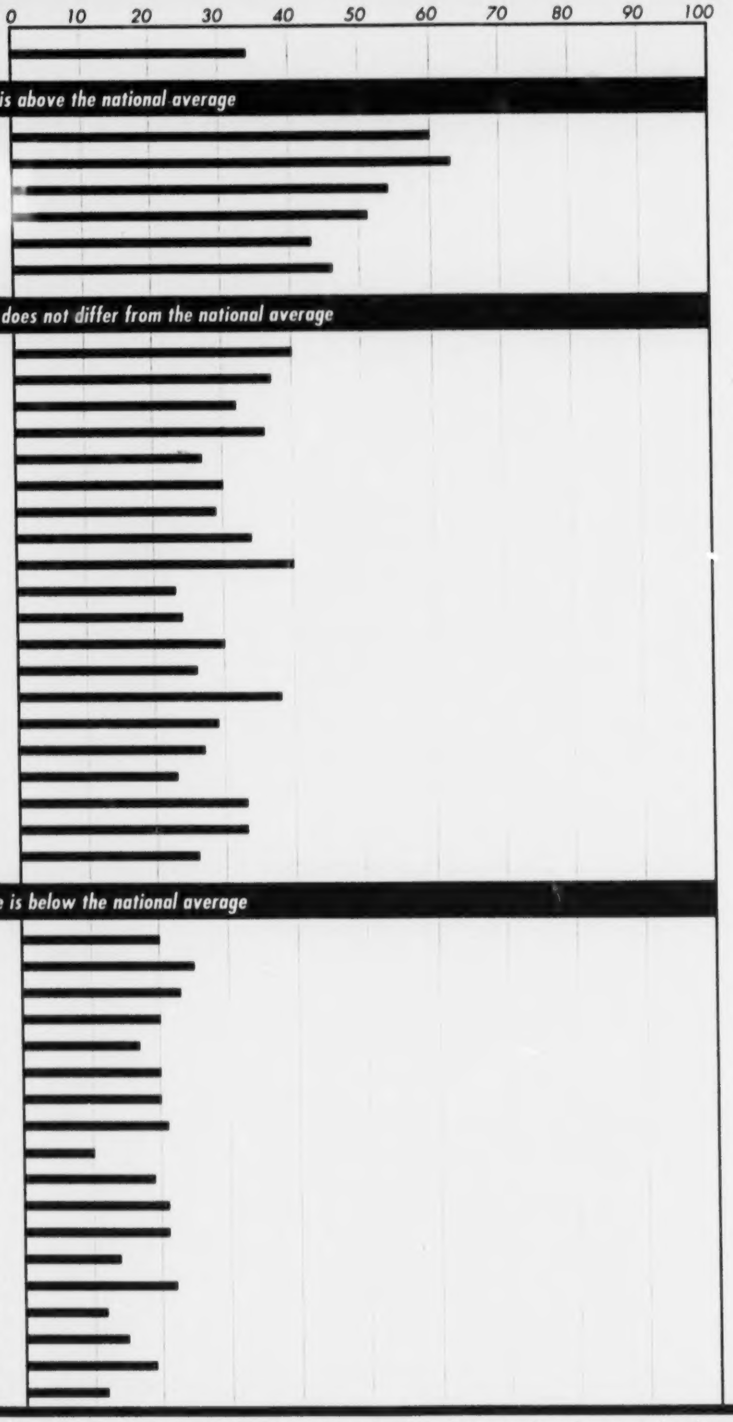
FIGURE 2.6

Teachers' Reports on Professional Development Activities Over the Last Five Years in Teaching Students with Multicultural Backgrounds and/or Limited English Skills, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

Grade 8



	Percentage of Students Whose Teachers Responded Yes	Total % At or Above Proficient
Nation	34	27
Jurisdictions where the percentage is above the national average		
California	60	20
Florida	63	21
Guam	54	7
Nebraska	51	35
New Mexico	43	19
Texas	46	23
Jurisdictions where the percentage does not differ from the national average		
Alaska°	40	31
Arizona	37	23
Arkansas°	32	22
Colorado	36	32
Connecticut	27	36
DoDDS	30	31
District of Columbia	29	5
Georgia	34	21
Maryland°	40	25
Massachusetts	23	37
Michigan°	24	32
Minnesota	30	37
Missouri	26	28
North Carolina	38	24
Oregon	29	32
Rhode Island	27	26
Tennessee	23	22
Utah	33	32
Virginia	33	27
Washington	26	27
Jurisdictions where the percentage is below the national average		
Alabama	20	18
Delaware	25	21
DDESS	23	27
Hawaii	20	15
Indiana	17	30
Iowa°	20	36
Kentucky	20	23
Louisiana	21	13
Maine	10	41
Mississippi	19	12
Montana°	21	41
New York°	21	27
North Dakota	14	41
South Carolina°	22	17
Vermont°	12	34
West Virginia	15	21
Wisconsin°	19	39
Wyoming	12	34

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Summary

The data collected during the NAEP 1996 science assessment present a picture of who was teaching science to the nation's fourth and eighth graders.

Grade 4

Academic Background

- Approximately three-fifths of students were taught by teachers who reported a bachelor's degree as their highest degree.
- Students in public schools were more likely to be taught by teachers who reported holding a master's or specialist's degree than their counterparts in nonpublic schools.
- Seventy-four percent of students were taught by teachers who reported that they held an undergraduate or graduate college major in education.
- Teachers of 16 percent of the nation's students reported holding an undergraduate or graduate major or minor in science or science education.

Teacher Certification

- Ninety-five percent of public school students were taught by teachers who reported that they were certified to teach in their main assignment field and 27 percent of public school students had teachers who reported that they were certified in the area of science.

Teaching Experience

- Teachers of 48 percent of students reported 11 or more years of teaching experience.

Professional Development

- Sixteen percent of students were taught by teachers who reported attending 16 or more hours of professional development in science or science education during the year prior to the assessment.
- Teachers of 77 percent of students reported that they had some professional development activity in the use of technology and/or telecommunications during the five years prior to the assessment.

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Grade 8

Academic Background

- Approximately three-fifths of students were taught by teachers who reported that their highest degree was a bachelor's degree.
- Fifty-two percent of students were taught science by teachers who reported having an undergraduate or graduate major or minor in science.

Teaching Certification

- Teachers of 92 percent of public school students reported being certified to teach in their main assignment field, and teachers of 72 percent of public school students reported being certified to teach science.

Grade 8 Teaching Experience

- Teachers of 45 percent of students reported 11 or more years of teaching experience.

Professional Development

- Fifty-five percent of students were taught by teachers who reported spending 16 or more hours in professional development in science or science education during the year prior to the assessment.
- Teachers of 70 percent of students reported having some professional development activity in the use of technology and/or telecommunications during the five years prior to the assessment.

Chapter 3

What Emphasis Does Science Receive?

Does a district or state science curriculum exist? How often is science taught? Are advanced courses available for students? The background questions to which students, their teachers, and administrators of their schools responded as part of the NAEP 1996 science assessment provide answers to these and other questions, allowing some measure of the level of emphasis that science instruction receives in U.S. schools. Chapter 3 discusses the results. The reader is reminded that the relationships between school and student variables and student performance are complex. It is often impossible to assign cause and effect to a single variable when statistical correlations exist. It is also impossible to interpret an absence of statistical correlation as an indication of no cause and effect because the effects may be masked by other factors.

A well-crafted curriculum is a central part of a good science program and a critical ingredient in educational reform. Much of the current thinking expressed in documents such as the *National Science Education Standards* and *Benchmarks for Science Literacy* calls for the development and implementation of new curricula — a costly process.[1] According to a study conducted by the CCSSO, as of December 1994, 32 states had a "framework or curriculum-related document" in science and another 10 states had a combined mathematics and science curriculum. Moreover, 25 states were in the process of developing new science frameworks, four more were developing mathematics/science frameworks, and 18 were revising existing frameworks. One indication of the rapid pace at which change has been occurring is that in all 18 of the states that were revising their frameworks, the existing frameworks were no more than 10 years old and many were fewer than 5 years old.[2]

NAEP asked school administrators to indicate whether there was a state or district science curriculum that their school was expected to follow. However, the term curriculum was not defined in the questionnaire and the resulting data may reflect a wide range of interpretations. A state or district curriculum may be as simple as a list of science topics that should be covered in the K-12 science program or the textbooks that will be used in particular courses. Or a curriculum may be more detailed and include standards defining what students should

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[1] National Research Council of the Academy of Sciences. (1995). *National science education standards.* Washington, DC: Author.
American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* Washington, DC: Author.
National Science Teachers Association. (1992). *The content core: Scope, sequence, and coordination guide.* Washington, DC: Author.
Raizen, S.A. (1994). Approaches to the science curricula for grades K-12. In Fitzsimmons, S.J., and Kerpelman, L.C., (Eds.). *Teacher enhancement for elementary and secondary science and mathematics: Status, issues, and problems.* Washington, DC: National Science Foundation.

[2] Blank, R. K. & Pechman, E.M. (1995). *State curriculum frameworks in mathematics and science: How are they changing across the states?* Washington, DC: Council of Chief State School Officers.

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know and be able to do after completing a course of study as well as the teaching strategies that should be used in introducing the topics to students.[3] The administrators indicated that 92 percent, 94 percent, and 83 percent of students in grades 4, 8, and 12, respectively, attended public schools in districts or states that have a science curriculum, although it is not clear how many of the science curricula were new or revised (see Table 3.1). An examination of student performance revealed that public school students in grade 12 whose schools were expected to follow a district or state curriculum in science had lower scale scores than students whose schools were not expected to follow one. There were no significant differences in scale scores in grades 4 and 8. A larger percentage of students at the fourth-grade level whose schools were expected to follow a district or state curriculum were at or above the *Proficient* level. No differences were seen at the eighth- and twelfth-grade level for students at or above the *Proficient* level.

TABLE 3.1

Schools' Reports on Whether They Have a Science Curriculum: Public Schools Only

THE NATION'S REPORT CARD naep

Does your district or state have a curriculum in science that your school is expected to follow?	**Grade 4**	**Grade 8**	**Grade 12**
	Percentage of Students		
Yes			
Percentage of Students	92	94	83
Average Scale Score	149	149	149
Percentage At or Above *Proficient*	28	27	20
No			
Percentage of Students	8	6	17
Average Scale Score	140	151	156
Percentage At or Above *Proficient*	18	31	26

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Schools' Reports on the Frequency of Science Instruction at Grades 4 and 8

School administrators of students in grades 4 and 8 were asked how often students in their schools received instruction in science. The national data are reported in Table 3.2. In fourth grade, 48 percent of students received science instruction every day and a further 39 percent received science instruction three to four times a week. In eighth grade, 91 percent of students had daily instruction.[4] There were no significant differences in average scale scores or percentages of students at or above *Proficient* related to how often students received science instruction.

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[3] Raizen, S.A. (1997). *Standards for science education.* Madison, WI: National Institute for Science Education.

[4] When interpreting the frequency-of-instruction data, it might be helpful to keep in mind that flexible scheduling options used in some schools may result in the equivalent daily instruction being offered in a more condensed period of time.

TABLE 3.2 Schools' Reports on How Often a Typical Student Receives Instruction in Science: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

How often does a typical fourth-grade student in your school receive instruction in science?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 4			
Every Day	48	151	29
3 - 4 Times a Week	39	150	30
1 - 2 Times a Week	14	147	25
Less Than Once a Week	0	—	—
Not Taught	0	—	—
How often does a typical eighth-grade student in your school receive instruction in science?			
Grade 8			
Every Day	91	151	30
3 - 4 Times a Week	8	151	30
1 - 2 Times a Week	1	—	—
Less Than Once a Week	0	—	—
Not Taught	0	—	—

— Sample size is insufficient to permit a reliable estimate.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

State data concerning how often a typical public school eighth grader received instruction in science are presented in Table 3.3. At least 90 percent of public school students in 32 jurisdictions had daily science instruction. In 11 jurisdictions, 75 to 89 percent of public school students had daily instruction. In Hawaii, where science instruction is not a state requirement at the eighth-grade level, 31 percent of public school students attended schools that reported offering science instruction less than three times a week.[5] Twenty-one percent of these received no science instruction as reported by their schools at that grade.

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[5] Source: Hawaii State Education Department, 1997.

TABLE 3.3

Schools' Reports on How Often a Typical Student Receives Instruction in Science, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

How often does a typical eighth-grade student in your school receive instruction in science?

Grade 8	Every Day		3 - 4 Times per Week		Less than 3 Times per Week		Total % At or Above *Proficient*
	% of Students	Average Scale Score	% of Students	Average Scale Score	% of Students	Average Scale Score	
Nation	92	150	8	147	0	—	27
Alabama	98	139	0	—	2	—	18
Alaska°	75	152	23	150	1	—	31
Arizona	94	146	4	—	2	—	23
Arkansas°	99	145	1	—	0	—	22
California	87	137	8	137	5	—	20
Colorado	97	154	3	—	0	—	32
Connecticut	97	157	1	—	2	—	36
Delaware	100	142	0	—	0	—	21
DDESS	100	152	0	—	0	—	27
DoDDS	94	155	6	—	0	—	31
District of Columbia	79	114	11	106	10	—	5
Florida	89	144	9	126	2	—	21
Georgia	99	142	1	—	0	—	21
Guam	100	119	0	—	0	—	7
Hawaii	34	133	35	136	31*	139	15
Indiana	99	154	0	—	1	—	30
Iowa°	97	158	3	—	0	—	36
Kentucky	96	147	4	—	1	—	23
Louisiana	100	133	0	—	0	—	13
Maine	86	163	14	164	0	—	41
Maryland°	96	146	4	—	0	—	25
Massachusetts	96	157	3	—	1	—	37
Michigan°	100	153	0	—	0	—	32
Minnesota	87	160	9	158	5	—	37
Mississippi	93	134	7	129	0	—	12
Missouri	84	151	15	147	1	—	28
Montana°	98	162	1	—	0	—	41
Nebraska	96	158	2	—	1	—	35
New Mexico	95	142	0	—	5	—	19
New York°	94	147	6	139	0	—	27
North Carolina	94	146	3	—	3	—	24
North Dakota	99	163	1	—	0	—	41
Oregon	83	155	17	154	0	—	32
Rhode Island	98	149	2	—	0	—	26
South Carolina°	95	139	5	—	0	—	17
Tennessee	97	144	0	—	3	—	22
Texas	77	149	22	136	1	—	23
Utah	93	156	5	—	2	—	32
Vermont°	84	157	16	158	0	—	34
Virginia	92	150	8	144	0	—	27
Washington	82	150	9	146	9	148	27
West Virginia	98	147	1	—	1	—	21
Wisconsin°	100	160	0	—	0	—	39
Wyoming	100	158	0	—	0	—	34

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

— Sample size is insufficient to permit a reliable estimate.

* Twenty-one percent of students received no science instruction as reported by their schools.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Grade 12 Graduation Requirements

Years of Science Required

There is considerable debate over how most effectively to meet the challenge of educating high school students to be scientifically literate and able to compete in an increasingly technological global economy. Although the raising of content and performance standards has in recent years become the preferred focus of much educational reform, some states have chosen, either in addition or instead, to require students to take more hours of science as a requirement for graduation.[6] From 1990 to 1995, the number of states requiring 2.5 to 3.0 Carnegie course units for graduation increased from 4 to 12. Over the same period, the number of states in which only one Carnegie unit in science was required for graduation declined from eight to two.[7] Individual school districts often set stricter standards than their states. For example, while states may mandate a minimum requirement for graduation of two years of science, districts within that state may require students to take three or more years of science.[8]

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[6] Blank, R.K. & Gruebel, D. (1995). *State indicators of science and mathematics education, 1995*. Washington, DC: Council of Chief State School Officers.

Layman, J.W. (1996) *Inquiry and learning: Realizing science standards in the classroom*. New York, NY: College Entrance Examination Board.

[7] A Carnegie unit is the equivalent of a course taught daily for one year. Blank, R.K. & Gruebel, D. (1995). *State indicators of science and mathematics education*. Washington, DC: Council of Chief State School Officers.

[8] National Center for Education Statistics. (1993). *Schools and staffing in the United States: A statistical profile, 1990-91*. Washington, DC: U.S. Department of Education.

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TABLE 3.4 Schools' Reports on Years of Science Required for Graduation: Public and Nonpublic Schools Combined

Beginning with 9th grade, how many years of course work does your school or district require for graduation this year?	**Grade 12**
	Percentage, Average Scale Score, and Achievement Level of Students
1 Year	
Percentage of Students	5
Average Scale Score	157
Percentage At or Above *Proficient*	24
2 Years	
Percentage of Students	63
Average Scale Score	152
Percentage At or Above *Proficient*	23
3 Years	
Percentage of Students	31
Average Scale Score	147
Percentage At or Above *Proficient*	18
4 Years	
Percentage of Students	1
Average Scale Score	—
Percentage At or Above *Proficient*	—

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

— Sample size is insufficient to permit a reliable estimate.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

As part of the NAEP 1996 science assessment, school administrators were asked to report how many years (or Carnegie-unit equivalents) of coursework their school or district required for graduation. The results are shown in Table 3.4. All but five percent of grade 12 students attended schools where at least two years of science coursework was required for graduation. Sixty-three percent of students attended schools or districts with a two-year requirement while 32 percent attended schools where the requirement was three or more years. By comparison, 43 percent of twelfth-grade students were required to take two years of mathematics, whereas 54 percent had a three-or-more year requirement.[9] An analysis of scale scores of twelfth-grade students reveals that students who were required to take one year of science for graduation had higher scale scores than students who were required to take two years or three years of science. The data relating to 4 years could not be reported, however, due to insufficient sample size. This counter-intuitive finding should not be confused with how students perform when they study more science because the data on science requirements do not tell exactly how much coursework in science students actually had. The percentage of twelfth-grade students reaching the *Proficient* level did not vary significantly with the number of years of science their schools said were required for graduation.

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[9] National Center for Education Statistics. National Assessment of Educational Progress. (1997). *1996 Mathematics assessment summary data tables* [On-line]. Available: http://nces.ed.gov/naep/tables96/index.shtml.

Just as individual school districts sometimes establish more stringent graduation requirements than their states, students can — and often do — choose to take science courses beyond those required by their district or state. Data from seniors responding to a question about how many semester hours of science they had taken beginning in ninth grade reveal that 23 percent had taken four to five semester hours of science, 26 percent had taken six to seven, and 29 percent had taken eight or more (see Table 3.5). Among college-bound students, the percentages were even higher according to data collected by the College Board. For 1996, 48 percent of students taking the SAT reported having four or more years of science coursework and 38 percent reported having three years of science. Only 15 percent had two or fewer years of science.[10]

TABLE 3.5

Students' Reports on Semester Hours of Science Taken from Grades 9 - 12: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

From the beginning of 9th grade through the end of the school year, how many semester hours (or equivalent) of course work will you have taken in science?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 12			
None - 1	2	110	1
2 - 3 Semesters	20	128	4
4 - 5 Semesters	23	147	14
6 - 7 Semesters	26	158	23
8 or More Semesters	29	172	44

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Table 3.5 also depicts average scale scores and percentages of students at or above *Proficient*. The results are not surprising. As can be seen from the data, higher numbers of semester hours of coursework were associated with higher average scale scores and a greater percentage of students at or above *Proficient*. For example, twelfth graders who reported taking eight or more semester hours of coursework in science had a higher average scale score than students who reported fewer semester hours of course taking. Similarly, 44 percent of students who took eight or more semesters of science coursework were at or above *Proficient*. This percentage was significantly higher than the percentages of students at or above *Proficient* who had taken fewer semester hours of coursework. Thus, the more science coursework students took the higher was their achievement on the NAEP 1996 science assessment.

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[10] The College Entrance Examination Board and Educational Testing Service. (1996). *1997 college-bound seniors: A profile of SAT program test takers.* New York, NY: Author.

Advanced Course Offerings

NAEP also sought to determine what types of advanced science courses schools offer. As shown in Table 3.6, some form of science beyond an introductory course was offered in nearly all schools. According to school administrators, 83 percent, 65 percent, and 51 percent of twelfth graders attended schools that offered advanced courses in biology, chemistry, and physics, respectively.[11] However, 10 percent of students attended schools where no advanced courses were offered. When average scale scores are examined, students in schools that offered no advanced science courses had lower average scale scores than did their counterparts in schools that reported offering such courses. This result was also reflected in the achievement levels. Again, the percentage of students at or above *Proficient* was significantly lower in schools that reported not offering advanced courses compared to those that did.

TABLE 3.6

Schools' Reports on Types of Advanced Level Courses Taught: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

Are courses of at least one semester in length taught in your school in each of the following subjects?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 12			
Advanced Biology	83	152	22
Advanced Chemistry	65	154	24
Advanced Physics	51	153	24
None Taught	10	139	11

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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[11] The terms "advanced biology," "advanced chemistry," and "advanced physics" were defined in the school questionnaire as "beyond an introductory course." It cannot be determined what percentage of responses include courses in the Advanced Placement Program among the advanced courses.

State/District Tests

Education policy makers have also tried to raise the proficiency of students by instituting mandatory graduation examinations in a variety of subjects. Such assessments, it is hoped, will help to raise standards by requiring students to achieve a designated level of competency. Since the assessments are generally designed as part of larger curriculum reform efforts, it is also hoped that they will serve to drive the curriculum in the direction of the reforms by getting educators to teach to the tests.[12] In 1996, seventeen states reported having assessments in place in one or more subject areas that were used as a requirement for high school graduation.[13] These assessments may or may not have included science. The New York State Regents Examination, long a benchmark for the assessment of college-bound students, is currently being transformed so that all students will have to pass examinations in several subjects before graduating from high school. The science regents examination is expected to be in place in the year 2001.

As shown in Table 3.7, about one-sixth of grade 12 students attended schools that reported a requirement to pass a district or state science test in order to graduate. In contrast, 55 percent of students attended schools in which a district or state mathematics test was required.[14] The proportion of students that have to pass a science examination for graduation will surely increase in the next few years as new state and district tests are brought on line.[15] An analysis of scale scores and percentage of students at the *Proficient* level revealed that average performance was similar whether or not students were required to pass a district or state test in science in order to graduate.

TABLE 3.7 **Schools' Reports on Requirements to Pass a District or State Test in Science in Order to Graduate: Public and Nonpublic Schools Combined**

THE NATION'S REPORT CARD naep

Are students in your school required to pass a district or state test in science in order to graduate?	Yes	No
Grade 12	**Percentage, Average Scale Score, and Achievement Level of Students**	
Percentage of Students	17	83
Average Scale Score	148	152
Percentage At or Above *Proficient*	21	22

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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[12] Mestre, J. P. (1994). Cognitive Aspects of Learning and Teaching Science. In Fitzsimmons, S.J., & Kerpelman, L.C. (Eds.). *Teacher enhancement for elementary and secondary science and mathematics: Status, issues, and problems.* Washington, DC: National Science Foundation.

[13] Council of Chief State School Officers. (1996). *Annual survey of state student assessment programs.* Washington, DC: Author.

[14] National Center for Education Statistics, National Assessment of Educational Progress (1997). *1996 Mathematics assessment summary data tables* [On-line]. Available: http://nces.ed.gov/naep/tables96/index.shtml.

[15] Council of Chief State School Officers. (1996). *Annual survey of state student assessment programs.* Washington, DC: Author.

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Summary

States, districts, and schools differ in the emphasis they give to science instruction in the fourth, eighth and twelfth grades. The NAEP 1996 science assessment afforded an opportunity to examine these differences using information collected from school administrators. Students at grade 12 were also asked a series of questions about the science instruction they received.

Grade 4

- Ninety-two percent of students attended public schools in states or districts with a science curriculum in place.
- Eighty-seven percent of students received instruction in science three or more times a week.

Grade 8

- Ninety-four percent of students attended public schools in states or districts with a science curriculum in place.
- Ninety-nine percent of students received science instruction three or more times a week.

Grade 12

- Eighty-three percent of students attended public schools in states or districts where a science curriculum was in place.
- Five percent of students were required to take one year of science for graduation, 63 percent were required to take two years of science, and 31 percent were required to take three years of science.
- Twenty-six percent of students reported taking six or seven semesters of science and 29 percent reported taking eight or more semesters. Higher numbers of semester hours of science coursework were associated with higher average scale scores and a greater percentage of students at or above *Proficient*.
- Eighty-three percent of students attended schools that offered an advanced biology course, 65 percent had access to advanced chemistry, and 51 percent could take advanced physics.
- One out of 10 students attended schools in which no advanced science courses were offered. Students in these schools had lower average scale scores and fewer of them were at or above *Proficient* on the achievement level scale than their counterparts in schools that reported offering advanced courses.

Chapter 4

What Science Courses Are Our Nation's Students Taking?

The goal of the present reform movement is to produce scientifically literate individuals who will be able to make informed decisions.[1] There has been much debate in recent years about how to organize the science subject matter so that students have the opportunity to understand and make connections among the key ideas in the domains. There are a number of schools of thought on how to approach the teaching of a subject that includes several somewhat discrete but nevertheless interconnected parts. Traditionally, life science, physical science, and earth science have been taught in grades 7 to 9, followed by biology, chemistry, and physics. More recently, one movement has been to replace this sequence with a curriculum in which each of the major disciplines in science is studied every year from grades 7 through 12. In this curriculum the content is sequenced in a manner deemed consistent with cognitive development, from the concrete to the abstract.[2] Other curricula have also been proposed. For example, the National Center for Improving Science Education recommended that students take an integrated science course up to grade 11, at which point they would specialize.[3] The content standards prescribed in the National Science Education Standards have been divided into eight categories, seven of which are clustered for grade levels K-4, 5-8, and 9-12.[4] There has been no attempt to order the material within the clusters or to separate the domains into different grade levels.

As part of the NAEP 1996 science assessment, students in grade 8 but not in grade 4 were asked about the science courses they were taking and teachers of students who participated in the assessment at grades 4 and 8 were asked about the sciences they were teaching. At grades 4 and 8 course-taking information was collected only for the assessment year. Twelfth-grade students were asked to report on the science courses they had taken from grades 9 through 12. There was no teacher questionnaire at the twelfth-grade level.[5] Chapter 4 describes these results. It should be noted that science learning is cumulative and thus performance data reflect not only exposure to current courses but also past learning experiences. The reader is also cautioned about ascribing cause-and-effect relationships between the teacher and student variables and student performance because multiple interrelated factors contribute to student outcomes in education.

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[1] National Research Council of the Academy of Sciences. (1995). *National science education standards.* Washington, DC: Author.

[2] Aldridge, B.G. (1989). *Essential changes in secondary school science: Scope, sequence, and coordination.* Washington, DC: National Science Teachers Association.

[3] National Center for Improving Science Education. (1991). *The high stakes of high school science.* Washington, DC: Author.

[4] National Research Council of the Academy of Sciences. (1995). *National science education standards.* Washington, DC: Author.

[5] No questionnaires were administered to twelfth-grade teachers because students were not necessarily enrolled in science.

Grade 4 Science Courses

Students in grade 4 were not asked to describe the science course they were currently taking; however, their teachers were asked to specify how much time they spent teaching life science, earth science, and physical science. Teachers were presented with response options of "a lot," "some," "little," and "none." The results are shown in Table 4.1.

TABLE 4.1

Teachers' Reports on How Much Time is Spent Teaching Certain Science Domains: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

In this class, about how much time do you spend on each of the following areas in science?	Percentage of Students	Average Scale Score				Percentage At or Above *Proficient*
		Composite	Life Science	Earth Science	Physical Science	
Grade 4						
Life Science						
A Lot	28	150	151	150	150	29
Some	65	151	151	151	152	31
Little	6	150	151	151	150	26
None	1	—	—	—	—	—
Earth Science						
A Lot	19	151	152	151	151	31
Some	76	151	151	150	151	29
Little	5	151	148	153	153	29
None	0	—	—	—	—	—
Physical Science						
A Lot	16	154	155	154	154	34
Some	73	151	151	151	151	30
Little	9	145	145	146	146	25
None	2	137	136	139	134	16

—Sample size is insufficient to permit a reliable estimate.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

The results indicate that teachers of approximately 28 percent, 19 percent, and 16 percent of grade 4 students reported spending a lot of time covering life science, earth science, and physical science, respectively. The amount of exposure to the different science domains did not have an impact on the average scale scores of students or on the percentage of students that attained the *Proficient* level. No statistical differences were found. The amount of exposure to the different science domains also had no impact on the scale scores of students in the different domains. For example, students who received little instruction in life science performed as well on life science questions as students who received a lot of life science instruction.

Grade 8 Science Courses

Teachers of eighth-grade students were asked how much time they spent teaching life science, earth science, and physical science. Teachers were given response options of "a lot," "some," "little," and "none." The results are shown in Table 4.2.

TABLE 4.2

Teachers' Reports on How Much Time is Spent Teaching Certain Science Domains: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

In this class, about how much time do you spend on each of the following areas in science?	Percentage of Students	Average Scale Score				Percentage At or Above *Proficient*
Grade 8		Composite	Life Science	Earth Science	Physical Science	
Life Science						
A Lot	19	149	148	149	150	28
Some	40	150	151	150	150	29
Little	23	156	155	157	155	34
None	18	157	159	156	155	35
Earth Science						
A Lot	41	151	151	152	150	30
Some	39	151	151	152	152	30
Little	11	155	157	152	155	36
None	9	157	161	155	155	34
Physical Science						
A Lot	49	153	153	152	153	32
Some	35	153	153	153	152	32
Little	12	154	153	156	152	32
None	4	144	149	143	139	21

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Forty-one percent and 49 percent of eighth-grade students were taught by teachers who reported spending a lot of time teaching earth science and physical science, respectively. Nine percent and four percent of students were taught by teachers who indicated that they had not taught earth science or physical science. About the same percentage of students had teachers who indicated that they spent either a lot of time teaching life science or teaching no life science, 19 and 18 percent, respectively. The amount of exposure to the different science domains did not influence the composite, life science, earth science, or physical science average scale score of students or the percentage of students at or above *Proficient*.

As part of the grade 8 questionnaire, students were asked what science course they were currently taking. The categories given were as follows:

- I am not taking a science course this year;
- Life science (for example, biology);
- Physical science (for example, physics or chemistry);
- Earth science (for example, geology or astronomy);
- General science (several content areas of science taught separately); and
- Integrated science (several content areas of science combined and taught together throughout the year).

TABLE 4.3 **Students' Reports on Science Course-Taking: Public and Nonpublic Schools Combined**

THE NATION'S REPORT CARD naep

Which best describes the science course you are taking?	Percentage of Students	Average Scale Score				Percentage At or Above *Proficient*
		Composite	Life Science	Earth Science	Physical Science	
Grade 8						
Life Science	13	137	136	137	137	18
Physical Science	26	156	156	155	156	34
Earth Science	24	150	150	150	149	29
General Science	18	157	156	157	157	34
Integrated Science	16	157	157	156	157	34
No Science	3	121	123	119	123	6

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Table 4.3 shows that almost all students (97 percent) reported that they were taking a science course. Of these, approximately 25 percent of the nation's eighth graders were taking an earth science course and a similar percentage were taking a physical science course. Sixteen percent and 18 percent were taking integrated science and general science, respectively, while 13 percent reported taking life science and 3 percent reported taking no science. For the nation, students who were taking no science courses had a significantly lower scale score than those students who were taking a science course. The percentage of students who scored at or above the *Proficient* level was lower among students not taking science than among those taking physical, earth, general, or integrated science. Among students who reported taking science, those taking life science had a significantly lower scale score than students taking physical, earth, general, or integrated science. Achievement level data also show that the percentage of students at or above the *Proficient* level was significantly lower for students taking life science than for students taking physical, general, or integrated science.

An examination of student performance on the life, earth, and physical science portions of the assessment shows that students who took no science courses had lower life, earth, and physical science scale scores than students who took physical, earth, general, or integrated science courses. In addition, students who took no science courses had lower earth science scale scores than students who took a life science course. Students who took a life science course had lower scale scores in the three domains than students who took any other science course, with one exception: there was no difference in student performance in physical science between those taking a life science course and those taking an earth science course.

There is no obvious explanation for the relatively lower scale scores of students who reported taking life science in grade 8. One possibility is that students taking physical, earth, general, or integrated science were exposed to more of the material being surveyed by the NAEP 1996 science assessment. For example, students taking physical science were also likely to be exposed to some earth science material whereas students taking life science were less likely to be exposed to material from earth or physical science.

Grade 12 Science Courses

As part of the NAEP 1996 assessment, grade 12 students were presented with a list of science courses and asked how much science coursework they had completed in each of them. The courses specified were earth and space science, life science, biology, physical science, chemistry, physics, general science, integrated science, and science and technology. An additional category called "other science courses" was also included. Students were asked whether they had taken more than one year, one year, less than one year, or none of each particular course. The response options more than one year, one year, and less than one year were collapsed because courses may be set up in semester units or some students may take longer than one year to complete the course requirements. Since course-taking patterns traditionally vary between males and females, data from the NAEP 1996 science assessment are also reported by gender.[6] The student data were analyzed in two different ways. Tables 4.4a and 4.4b present data for the individual subject areas and Table 4.5 presents data for combinations of these same subject areas.

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[6] Campbell, J.R., Voelkl, K. E., & Donahue, P.L. (1997). *NAEP 1996 trends in academic progress: Achievement of U.S. students in science 1969 to 1996; mathematics, 1973 to 1996; reading, 1971 to 1996; and writing, 1984 to 1996* (NCES Publication No. 97-985). Washington, DC: National Center for Education Statistics.

Course-Taking Patterns — Biology, Chemistry, and Physics

Many schools offer a traditional sequence of science courses in high school. While ninth graders may still take physical science or earth science, many schools now teach these courses in the middle school and offer biology in the ninth grade, followed by chemistry and physics. NAEP data collected from eighth graders in 1996 indicated that approximately half of students had taken either earth science or physical science (Table 4.2). As indicated in Table 4.4a, almost all grade 12 students reported having taken a course in biology (95 percent of males and 97 percent of females). Seventy-two percent of males and 76 percent of females reported having taken chemistry, and 46 percent of males and 37 percent of females reported having taken physics. While the percentage of students who took biology was similar to that reported in the *NAEP 1996 Trends in Academic Progress*, the percentages of students who reported taking chemistry and physics were somewhat higher.[7] This outcome reflects the fact that whereas the NAEP 1996 science assessment was administered to students in grade 12, the students participating in the long-term trend assessment were 17-year-olds (eleventh graders) who may not yet have taken chemistry or physics. The average scale scores and percentages of grade 12 students reaching the *Proficient* level were significantly higher for those students who reported having taken biology, chemistry, and/or physics than those of their counterparts who reported not taking biology, chemistry, and/or physics. Male students who reported having taken biology outperformed female students who reported having taken biology. Similar results were found for both chemistry and physics.

TABLE 4.4a **Students' Reports on Science Courses Taken from Grades 9 - 12, by Gender: Public and Nonpublic Schools Combined**

THE NATION'S REPORT CARD

From the beginning of 9th grade to the present, how much science coursework have you completed in the following subjects?	All Students		Males		Females	
	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None
Grade 12						
Biology						
Percentage of Students	96	4	95	5	97	3
Average Scale Score	152	123	155	125	149	121
Percentage At or Above *Proficient*	23	5	27	6	18	3
Chemistry						
Percentage of Students	74	26	72	28	76	24
Average Scale Score	159	131	163	134	157	127
Percentage At or Above *Proficient*	29	5	35	8	23	3
Physics						
Percentage of Students	41	59	46	54	37	63
Average Scale Score	166	142	168	143	163	142
Percentage At or Above *Proficient*	39	12	44	14	34	10

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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[7] Campbell, J.R., Voelkl, K. E., & Donahue, P.L. (1997). *NAEP 1996 trends in academic progress: Achievement of U.S. students in science 1969 to 1996; mathematics, 1973 to 1996; reading, 1971 to 1996; and writing, 1984 to 1996* (NCES Publication No. 97-985). Washington, DC: National Center for Education Statistics.

Course-Taking Patterns — Earth and Space Science, Life Science, Physical Science, Integrated Science, and Science and Technology

Twelfth-grade students were also asked to report how many semesters (or the equivalent) of coursework they had taken from the beginning of ninth grade in six additional areas of science: earth and space science, life science, physical science, general science, integrated science, and science and technology. In addition students were asked to respond to a category entitled "other science courses." The results are shown in Table 4.4b.

Fifty-three percent of twelfth graders reported having taken earth and space science, 39 percent life science, 50 percent physical science, and 59 percent general science. Twenty-five percent of students reported having taken science courses not listed in Tables 4.4a and 4.4b.

The average scale scores and percentages of grade 12 students reaching the *Proficient* level were significantly higher for those students who reported not having taken earth and space science, life science, physical science, general science, and/or integrated science in grades 9 through 12. A possible explanation for the results is that students who take these courses in grades 9 through 12 tend not to be in the academic track and may have less opportunity to take courses such as chemistry and/or physics. Also in states and localities requiring two science course for graduation, earth science is often the course of choice for students in non-academic tracks because earth science is assumed to be less demanding than physics and chemistry.

As is shown in Table 4.4b, several differences were observed between the performance of grade 12 males and females who reported having taken the various science courses. Males who reported having taken earth and space science, physical science, and general science had higher average scale scores than females who reported having taken the same courses. The percentages of male students who reached the *Proficient* level was higher than the percentage of female students who reached the *Proficient* level for those students who reported having taken earth and space science, physical science, general science, science and technology, or other sciences. Female students who reported having taken any of the courses listed did not outperform males who reported having taken these same courses.

TABLE 4.4b

Students' Reports on Science Courses Taken from Grades 9 - 12, by Gender: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

From the beginning of 9th grade to the present, how much science coursework have you completed in the following subjects?	All Students		Males		Females	
	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None
Grade 12						
Earth & Space Science						
Percentage of Students	53	47	57	43	49	51
Average Scale Score	146	155	149	158	143	153
Percentage At or Above *Proficient*	17	26	21	32	13	21
Life Science						
Percentage of Students	39	61	41	59	37	63
Average Scale Score	143	155	143	159	143	151
Percentage At or Above *Proficient*	15	25	17	32	14	20
Physical Science						
Percentage of Students	50	50	50	50	49	51
Average Scale Score	147	154	150	156	144	152
Percentage At or Above *Proficient*	17	27	21	32	13	22
General Science						
Percentage of Students	59	41	64	36	56	44
Average Scale Score	142	162	144	166	139	158
Percentage At or Above *Proficient*	13	33	16	41	9	27
Integrated Science						
Percentage of Students	7	93	9	91	5	95
Average Scale Score	139	151	139	154	140	149
Percentage At or Above *Proficient*	15	22	15	27	16	18
Science & Technology						
Percentage of Students	14	86	20	80	9	91
Average Scale Score	150	151	152	154	144	149
Percentage At or Above *Proficient*	23	22	26	27	18	18
Other Science						
Percentage of Students	25	75	26	74	24	76
Average Scale Score	150	151	153	153	147	149
Percentage At or Above *Proficient*	20	22	25	27	15	18

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Course-Taking Patterns for Combinations of Subjects

In order to examine course taking further, the data were analyzed to ascertain how many students took courses in more than one of the four domains tested by the *Framework for the 1996 National Assessment of Educational Progress,* namely, earth science, chemistry, physics, and biology.[8] Table 4.5. shows the percentages of students taking various combinations of these courses, their average scale scores, and percentages of students at or above *Proficient*. The data are presented for all students and by gender. It should be noted that none of these combinations of courses are mutually exclusive. For example, if students were in the biology/chemistry/physics category they would also appear in three other categories: biology/chemistry, biology/physics, and chemistry/physics. The percentages of twelfth-grade students who reported having taken two or more courses ranged from 68 for those having taken biology/chemistry to 13 for those having taken earth science/biology/chemistry/physics.

For all twelfth graders, the average scale scores for those who reported taking any combination of courses were higher than for those students who reported not taking those courses, with the exception of earth science/biology, where the reverse was true.

The percentage of grade 12 students who reached the *Proficient* level varied depending on which combination of subjects they reported taking. The percentages were higher for students taking any combination of courses compared with students who did not take them with three exceptions. The percentage of twelfth-grade students who attained the *Proficient* level was lower for those who reported taking earth science/biology than those who did not. The percentages did not differ significantly for earth science/chemistry and earth science/biology/chemistry.

The relative performance of students who reported having taken different combinations of courses can also be compared. In general, students who reported having taken chemistry and physics among their science courses performed at a higher level than students who reported not having taken them.

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[8] National Assessment Governing Board. (1995). *Science framework for the 1996 National Assessment of Educational Progress.* Washington, DC: Author. The framework combines chemistry and physics under the heading "physical science." At grade 12, the life science domain is most equivalent to biology, even though it is called "life science" throughout the document.

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TABLE 4.5

Students' Reports on Combinations of Science Courses Taken from Grades 9 - 12, by Gender: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

From the beginning of 9th grade to the present, how much science coursework have you completed in the following subjects?	All Students		Males		Females	
	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None
Grade 12						
Earth & Biology						
Percentage of Students	45	55	48	52	42	58
Average Scale Score	147	154	150	156	144	152
Percentage At or Above *Proficient*	18	25	22	30	14	21
Earth & Chemistry						
Percentage of Students	32	68	34	66	30	70
Average Scale Score	155	149	157	152	152	147
Percentage At or Above *Proficient*	24	21	29	25	19	18
Earth & Physics						
Percentage of Students	17	83	20	80	14	86
Average Scale Score	160	149	162	152	157	147
Percentage At or Above *Proficient*	33	20	37	24	29	16
Biology & Chemistry						
Percentage of Students	68	32	66	34	71	29
Average Scale Score	160	132	163	135	157	129
Percentage At or Above *Proficient*	29	6	35	8	24	4
Biology & Physics						
Percentage of Students	35	65	39	61	32	68
Average Scale Score	167	142	170	143	164	142
Percentage At or Above *Proficient*	40	12	45	14	35	10
Chemistry & Physics						
Percentage of Students	34	66	37	63	31	69
Average Scale Score	169	143	172	144	166	142
Percentage At or Above *Proficient*	43	12	48	15	36	10
Earth, Biology & Chemistry						
Percentage of Students	30	70	31	69	29	71
Average Scale Score	155	149	158	151	153	147
Percentage At or Above *Proficient*	24	21	30	24	19	17
Earth, Biology & Physics						
Percentage of Students	15	85	18	82	12	88
Average Scale Score	161	149	164	151	158	147
Percentage At or Above *Proficient*	35	19	39	23	29	16
Earth, Chemistry & Physics						
Percentage of Students	14	86	16	84	11	89
Average Scale Score	164	149	166	151	161	147
Percentage At or Above *Proficient*	38	20	42	23	31	16
Biology, Chemistry & Physics						
Percentage of Students	32	68	34	66	29	71
Average Scale Score	170	142	173	143	166	141
Percentage At or Above *Proficient*	43	12	49	14	36	10
Earth, Biology, Chemistry & Physics						
Percentage of Students	13	87	16	84	11	89
Average Scale Score	165	149	168	151	161	147
Percentage At or Above *Proficient*	39	19	44	23	31	16

This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Are Students Studying Science in Grade 12?

In addition to being asked about their course-taking patterns, grade 12 students were asked whether or not they were currently taking a science course. The results are shown in Table 4.6. Fifty-four percent of students reported currently taking a science course, whereas 46 percent reported not taking one. Students who reported taking a science course had a significantly higher average scale score than did their counterparts who reported not taking any science at the time of the assessment. Similarly, the percentage of students at or above *Proficient* was significantly higher for those students taking science than for those not taking science. Data from the NAEP 1996 mathematics assessment show that 64 percent of grade 12 students were currently taking a mathematics course.[9] The students who chose to take mathematics in grade 12, like those who took science, had significantly higher scale scores than students who reported they were not currently taking a mathematics course.

Given the reforms currently taking place in science education and the emphasis on increased scientific literacy, it is interesting to note that almost half of all twelfth-grade students were not taking a science course and that two-thirds of them had not taken a course in one of the major domains, namely physics. Data from the Third International Mathematics and Science Study (TIMSS) show that 53 percent of U.S. students in their final year of secondary school reported that they were taking a science course. This is very similar to the results obtained by NAEP. In approximately two-thirds of the 20 countries that participated in the TIMSS assessment, the percentage of students who reported taking one or more science courses was higher than in the U.S.[10]

TABLE 4.6 **Students' Reports on Current Science Course-Taking: Public and Nonpublic Schools Combined**

THE NATION'S REPORT CARD

Are you currently taking a science course this year?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 12			
Yes	54	160	32
No	46	140	11

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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[9] National Center for Education Statistics, National Assessment of Educational Progress. (1997). *1996 Mathematics Assessment Summary Data Tables* [On-line]. Available: http://nces.ed.gov/naep/tables96/index.html.

[10] Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1998). *Mathematics and science achievement in the final year of secondary school.* Boston College, MA: TIMMS International Study Center.

Summary

In grade 4 students are most likely to be taking general science. As they progress to grade 8 the sciences tend to become domain specific and courses are offered under titles such as life science or physical science. At the high school level many different science courses may be offered. These can range from more traditional courses such as biology, chemistry, or physics to more specialized courses such as science and technology. The NAEP 1996 assessment asked teachers of students in grades 4 and 8 questions about the courses they were teaching. Students in grades 8 and 12 were asked what science courses they had taken.

Grade 4 Course-Taking

- Teachers of 28 percent, 19 percent, and 16 percent of students reported having spent a lot of time covering life science, earth science, and physical science, respectively. The amount of exposure to these science domains was not related to the average scale scores of students or the percentages of students who reached the *Proficient* level.

Grade 8 Course-Taking

- Ninety-seven percent of students reported taking a science course in the assessment year.
- Students who were taking life science had significantly lower scale scores than their counterparts who were taking physical science, earth science, general science, and/or integrated science.
- Forty-one percent and 49 percent of students were taught by teachers who reported spending a lot of time teaching earth science and physical science, respectively. Nineteen percent of students had teachers who indicated that they had spent a lot of time teaching life science.

Grade 12 Course-Taking

- At the secondary level, 57 percent of males and 49 percent of females reported taking earth and space science.
- Almost all students reported taking biology (95 percent of males and 97 percent of females).
- Seventy-two percent of males and 76 percent of females reported taking chemistry.
- Forty-six percent of males and 37 percent of females reported taking physics.
- Students who reported taking biology, chemistry, and/or physics in grades 9-12 outperformed their counterparts who reported not taking these subjects.
- Students who did not take courses in earth and space science, life science, general science, physical science, and/or integrated science in grades 9 through 12 outperformed students who reported taking these subjects.
- Male students who reported taking biology outperformed female students who reported taking biology. Similar results were found for both chemistry and physics.
- Fifty-four percent of students reported that they were currently taking a science course, whereas 46 percent reported that they were not currently taking one. The performance of students who reported taking a science course was significantly higher than the performance of those students who reported not taking a science course.

Chapter 5

Do Schools Have the Resources They Need to Support Science Learning?

Teachers often see the lack of resources and materials as a key roadblock to successful science instruction. In 1993, a national survey of elementary and secondary school educators found that deficiencies related to instructional resources were the most serious problems for science instruction in their schools.[1] Schools reported spending a total of $0.51 per elementary student per year and $0.88 per middle grade student per year on science supplies. They also reported spending $50 per year on science software at a time when the average price for a single software title was $100. This chapter examines data from teachers' responses to questions about the resources they have available to teach science, including curriculum specialists, computers, and laboratory space. The chapter also discusses student performance and indicates when statistically significant correlations exist. The reader is cautioned against overinterpreting the results. If no statistically significant correlations exist, there may still be cause-and-effect relationships, however, these may be masked by other factors. Similarly when statistically significant correlations do exist, it is also impossible to assign cause and effect to a single variable since many factors impact student performance.

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[1] Weiss, I.R. (1994). *A profile of science and mathematics education in the United States, 1993.* Chapel Hill, NC: Horizon Research.

Availability of Instructional Resources

Teachers of students in grade 4 who participated in the NAEP 1996 science assessment were asked how well their school systems provided them with instructional materials and other resources needed for classroom instruction. The results are shown in Table 5.1. Fifty-nine percent of fourth graders had teachers who reported receiving all or most of the resources they needed to teach their classes, whereas 40 percent reported receiving some of the resources. There was no significant difference in performance between the two groups.

At grade 8, approximately two-thirds of students had teachers who reported receiving all or most of the resources they needed. Nearly all the remaining students (34 percent) were taught by teachers who indicated that they received some resources. Very few students (approximately one percent) were taught by teachers who reported receiving no resources. Eighth-grade students whose teachers reported receiving all or most of the resources they needed had average scale scores that were significantly higher than their counterparts whose teachers indicated receiving some or none of their resources. The pattern was identical for achievement-level data.

Public school teachers whose eighth-grade students participated in state NAEP were also asked how well their school system provided them with instructional materials and other resources. The public school results for the nation and the jurisdictions are shown alphabetically in Table 5.2. The response categories are the same as those depicted in Table 5.1. Figure 5.1 presents the percentages of eighth-grade public school students whose teachers reported having all or most of the resources they needed. The jurisdictions are divided into three groups: states where the percentages were greater than that for the nation; states where the percentages did not differ significantly from that for the nation; and states where the percentages were lower than that for the nation.

TABLE 5.1

Teachers' Reports on Whether They Receive the Resources They Need: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

Which of the following statements is true about how well your school system provides you with instructional materials and other resources you need?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 4			
All or Most	59	152	30
Some	40	149	29
None	—	—	—
Grade 8			
All or Most	65	155	34
Some	34	145	24
None	1	135	15

— Sample size is insufficient to permit a reliable estimate.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

The data in Table 5.2 show that between 8 and 80 percent of students had teachers who reported receiving all or most of the instructional materials and other resources they needed. In the District of Columbia, 13 percent of students had teachers who reported that they received none of the resources they needed, and 10 percent of Louisiana students had teachers who reported the same lack of resources. The average scale score of students whose teachers reported receiving all or most of the resources they needed or some of the resources they needed ranged from 115 to 164 and 111 to 161, respectively.

TABLE 5.2

Teachers' Reports on Whether They Receive the Resources They Need, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

Which of the following statements is true about how well your school system provides you with instructional materials and other resources you need?	All or Most		Some		None		
	% of Students	Average Scale Score	% of Students	Average Scale Score	% of Student	Average Scale Score	Total % At or Above *Proficient*
Grade 8							
Nation	63	153	36	145	1	129	27
Alabama	40	142	57	136	3	—	18
Alaska[a]	56	154	44	147	0	—	31
Arizona	51	147	47	144	2	—	23
Arkansas[a]	59	146	40	142	1	—	22
California	54	143	44	136	1	—	20
Colorado	70	156	30	153	1	—	32
Connecticut	62	162	34	148	4	133	36
Delaware	39	142	57	143	4	129	21
DDESS	56	151	44	—	0	—	27
DoDDS	76	156	22	—	2	—	31
District of Columbia	8	115	80	111	13	105	5
Florida	55	142	42	142	3	130	21
Georgia	59	146	39	137	2	—	21
Guam	19	124	81	118	0	—	7
Hawaii	37	131	56	139	7	—	15
Indiana	65	157	35	149	0	—	30
Iowa[a]	78	160	20	155	1	—	36
Kentucky	76	148	24	150	0	—	23
Louisiana	40	138	51	131	10	132	13
Maine	53	165	45	161	2	157	41
Maryland[a]	53	149	47	143	0	—	25
Massachusetts	51	161	47	153	2	—	37
Michigan[a]	66	159	34	151	0	—	32
Minnesota	63	161	34	154	3	—	37
Mississippi	53	135	44	134	3	133	12
Missouri	64	154	35	151	1	—	28
Montana[a]	69	163	30	161	1	—	41
Nebraska	80	159	20	155	0	—	35
New Mexico	46	146	50	142	4	147	19
New York[a]	61	155	37	138	2	—	27
North Carolina	45	149	53	145	2	—	24
North Dakota	68	164	32	160	1	—	41
Oregon	52	157	48	155	0	—	32
Rhode Island	46	152	54	148	0	—	26
South Carolina[a]	52	141	47	136	1	—	17
Tennessee	48	149	51	141	1	—	22
Texas	71	150	27	139	2	—	23
Utah	57	159	42	152	1	—	32
Vermont[a]	57	158	43	156	0	—	34
Virginia	65	153	35	144	0	—	27
Washington	62	152	38	148	0	—	27
West Virginia	45	145	53	148	2	—	21
Wisconsin[a]	59	161	41	161	0	—	39
Wyoming	71	160	28	156	2	—	34

— Sample size is insufficient to permit a reliable estimate.

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

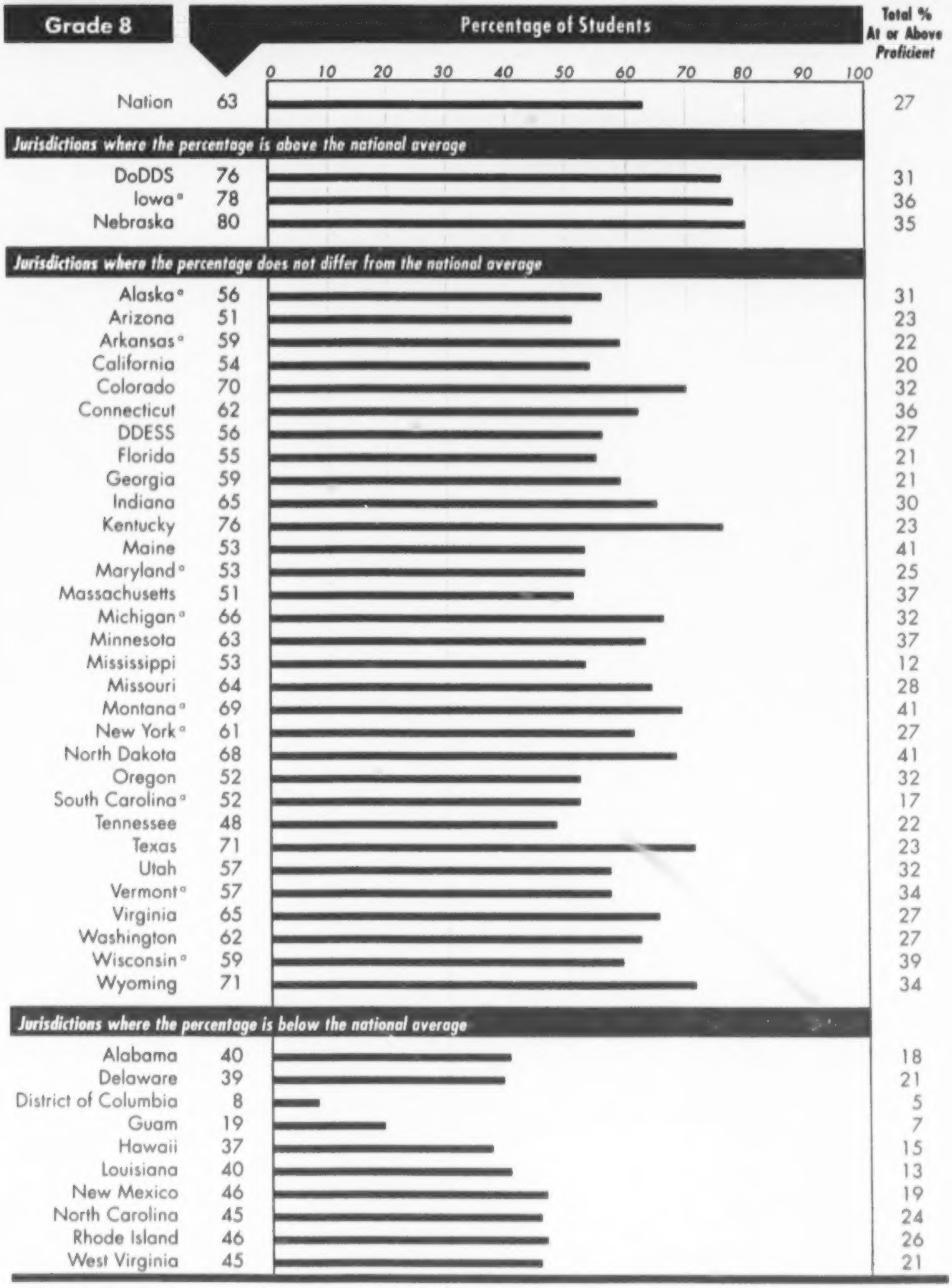
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Figure 5.1 shows that in 31 jurisdictions, the percentage of students whose teachers indicated that they received all or most of the instructional materials and other resources they needed was not significantly different than for the nation as a whole (63 percent). However, 10 jurisdictions were lower and three jurisdictions were higher than the national percentage. Among resource-poor jurisdictions, eight percent of students in the District of Columbia and 19 percent of students in Guam had teachers who reported receiving all or most of the resources they needed. Among jurisdictions with greater-than-average resources, the teachers of 80 percent of Nebraska students believed they were getting all or most of the resources they needed and the teachers of the remaining Nebraska students reported receiving some of the resources that they needed.

FIGURE 5.1

Teachers' Reports on Whether They Receive All or Most of the Resources They Need, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep



[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Availability of Computers for Use in Science Classes

The use of computers in teaching and learning is well documented.[2] In science, computers can be used in numerous ways, such as analyzing experimental results and accessing information. Their use is strongly supported in *Benchmarks for Science Literacy* and the *National Science Education Standards.*[3] However, while progress has been made in recent years to bring computers into the classroom, the cost of hardware, software, and training teachers to use computers as a tool for teaching and learning science remains a major burden for many districts.

Today, the many calls for U.S. schools to become "technology rich" may be closer to being realized due to new legislation that promises to provide $2.25 billion dollars over the next five years to build the infrastructure. *America's Technology Literacy Challenge* grew out of President Clinton's vision to connect every classroom in America to the information superhighway "with computers and good software and well-trained teachers."[4] The White House technology initiatives include four educational technology goals and proposals to help states achieve the goals. Information relating to the second of the goals, that "All teachers and students will have modern multimedia computers in their classrooms," was gathered by NAEP in 1996. It might be noted, however, that as of 1993 one teacher in five did not believe that computers should be used in science instruction.[5] Although that number is likely to decline as computers become increasingly integrated into all phases of life, at present it highlights an important disjuncture between the vision of universal computer access and the practice of science teachers.

Teachers of students in grades 4 and 8 were asked which best described the availability of computers for use by their science students (Figure 5.2). The response options presented were:

- None available;
- One within a classroom;
- Two or three within a classroom;
- Four or more within a classroom;
- Available in a computer laboratory but difficult to access or schedule; and
- Available in a computer laboratory and easy to access or schedule.

For the purposes of this report the categories one, two or three, and four or more within a classroom were collapsed to one or more computers in a classroom.

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[2] Smith, T.M., Young, B.A., Bae, Y., Choy, S.P., & Alsalam, N. (1997). *The condition of education, 1997.* Washington, DC: U.S. Department of Education, National Center for Education Statistics.

[3] American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* Washington, DC: Author. National Research Council of the Academy of Sciences. (1995). *National science education standards.* Washington, DC: Author.

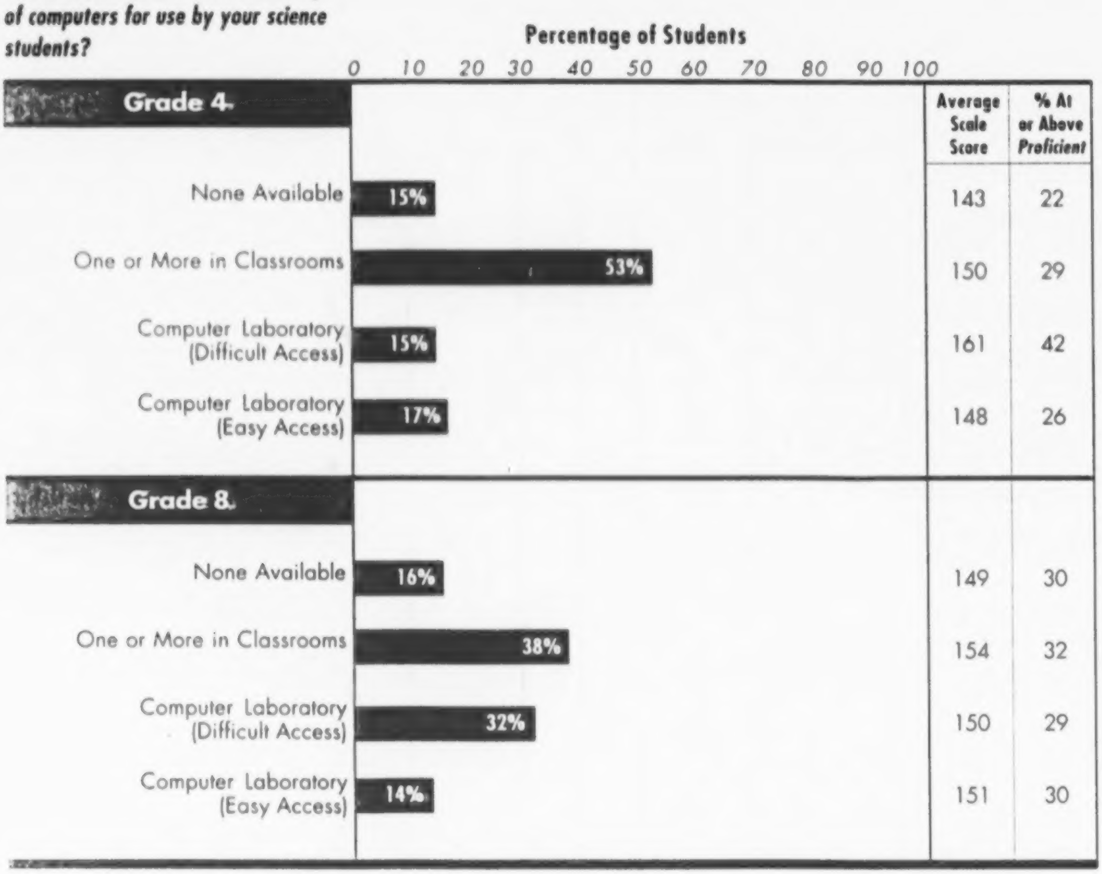
[4] Executive Office of the President. (1996). *National technology literacy goals.* Washington, DC: US Government Printing Office.

[5] Weiss, I. R. (1994). *A profile of science and mathematics education in the United States: 1993.* Chapel Hill, NC: Horizon Research.

FIGURE 5.2 **Teachers' Reports on Availability of Computers for Use by Their Science Students: Public and Nonpublic Schools Combined**

THE NATION'S REPORT CARD naep

Which best describes the availability of computers for use by your science students?



NOTE: Numbers may not add up to 100 due to rounding.
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

National Results

About 15 percent of students at grades 4 and 8 were taught by teachers who indicated that there were no computers available for use by their science students. However, among fourth graders, 53 percent had teachers who reported the availability of at least one classroom computer. For eighth graders, 38 percent had one or more computers in the classroom. Fifteen percent of fourth-grade students had teachers who indicated that it was difficult to access or schedule the use of computers in a computer laboratory, and slightly more (17 percent) were taught by teachers who indicated that it was easy to access or schedule computer use in a computer laboratory. According to their teachers, 32 percent of grade 8 students had difficulty accessing computers in a computer laboratory, and 14 percent had easy access to computers in a computer laboratory. These data tell only part of the story, however. Even when computers are available, teachers have to be able to use them effectively for instruction.[6] Fourth-grade students whose teachers reported that computers were available for use by their science students but were difficult to access had higher scale scores and percentages of students who reached the *Proficient* level than students for whom no computers were available, for whom one or more computers were available in classrooms, or for whom computers were easily accessible in computer laboratories. No differences in performance were seen at the eighth-grade level.

Jurisdiction Results

Public school teachers whose eighth-grade students participated in state NAEP were also asked to describe the availability of computers for use by their science students. The public school results for the nation and the jurisdictions are shown alphabetically in Table 5.3. The response categories are the same as those depicted in Figure 5.2. Figure 5.3 presents the percentages of eighth-grade public school students whose teachers reported having no computers available for use by their students. The jurisdictions are divided into three groups: states where the percentages were greater than that of the nation; states where the percentages did not differ significantly from that of the nation; and states where the percentages were lower than that of the nation.

The data in Table 5.3 show that the percentage of students in public schools across the nation and in most jurisdictions whose teachers reported having one or more computers in their classroom for use by their eighth grade-science students ranged from 18 percent in Maryland and Michigan to 67 percent in Hawaii. Between 8 and 51 percent of eighth graders had teachers who reported that computers were available in a computer lab but were difficult to access, whereas between 0 and 24 percent had easy access to computers in a computer laboratory.

The data in Figure 5.3 indicate that the percentage of students whose teachers reported having no computers available for use by their students was above the national average in six jurisdictions. In these jurisdictions (Arkansas, Delaware, Guam, Louisiana, Mississippi, and Utah), the range was 32 to 50 percent. In the nation the percentage was 17. In only one jurisdiction: DDESS, was the percentage of students below the national average. There, zero percent of students had teachers who reported having no access to computers.

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[6] Information concerning how computers are used in science education was presented in O'Sullivan, C. Y., Jerry, L., Ballator, N., & Herr, F. (1997). *NAEP 1996 science state reports.* (Publication No. NCES 97-499IA). Washington, DC: National Center for Education Statistics.

U.S. Department of Education, National Center for Education Statistics (in press). *Student Work and Classroom Practices in Science*. Washington, DC: Author.

TABLE 5.3

Teachers' Reports on Availability of Computers for Use by Their Science Students, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

Which best describes the availability of computers for use by your science students?	None Available	One or More in Classrooms	Computer Laboratory (Difficult Access)	Computer Laboratory (Easy Access)	Total % At or Above *Proficient*
Grade 8	Percentage of Students				
Nation	17	38	32	13	27
Alabama	29	39	27	5	18
Alaska°	7	49	37	7	31
Arizona	21	36	28	15	23
Arkansas°	44	28	22	6	22
California	18	48	23	11	20
Colorado	13	26	47	14	32
Connecticut	17	30	38	15	36
Delaware	38	24	29	9	21
DDESS	0	60	37	3	27
DoDDS	18	60	8	13	31
District of Columbia	14	49	23	14	5
Florida	19	50	23	9	21
Georgia	13	43	32	12	21
Guam	44	19	37	0	7
Hawaii	9	67	17	8	15
Indiana	15	24	38	23	30
Iowa°	9	42	39	11	36
Kentucky	7	40	36	17	23
Louisiana	47	22	19	12	13
Maine	9	35	44	11	41
Maryland	7	18	51	24	25
Massachusetts	16	37	34	14	37
Michigan°	24	18	39	19	32
Minnesota	10	26	47	17	37
Mississippi	50	20	20	9	12
Missouri	15	34	39	12	28
Montana°	8	38	40	14	41
Nebraska	7	44	33	16	35
New Mexico	23	33	33	10	19
New York°	26	20	35	19	27
North Carolina	13	26	43	19	24
North Dakota	12	36	36	16	41
Oregon	10	41	39	11	32
Rhode Island	13	21	47	19	26
South Carolina°	31	27	30	12	17
Tennessee	24	49	18	9	22
Texas	21	42	27	10	23
Utah	32	26	30	12	32
Vermont°	9	49	35	8	34
Virginia	10	30	42	18	27
Washington	11	46	28	15	27
West Virginia	23	34	35	9	21
Wisconsin°	9	36	40	15	39
Wyoming	9	55	25	11	34

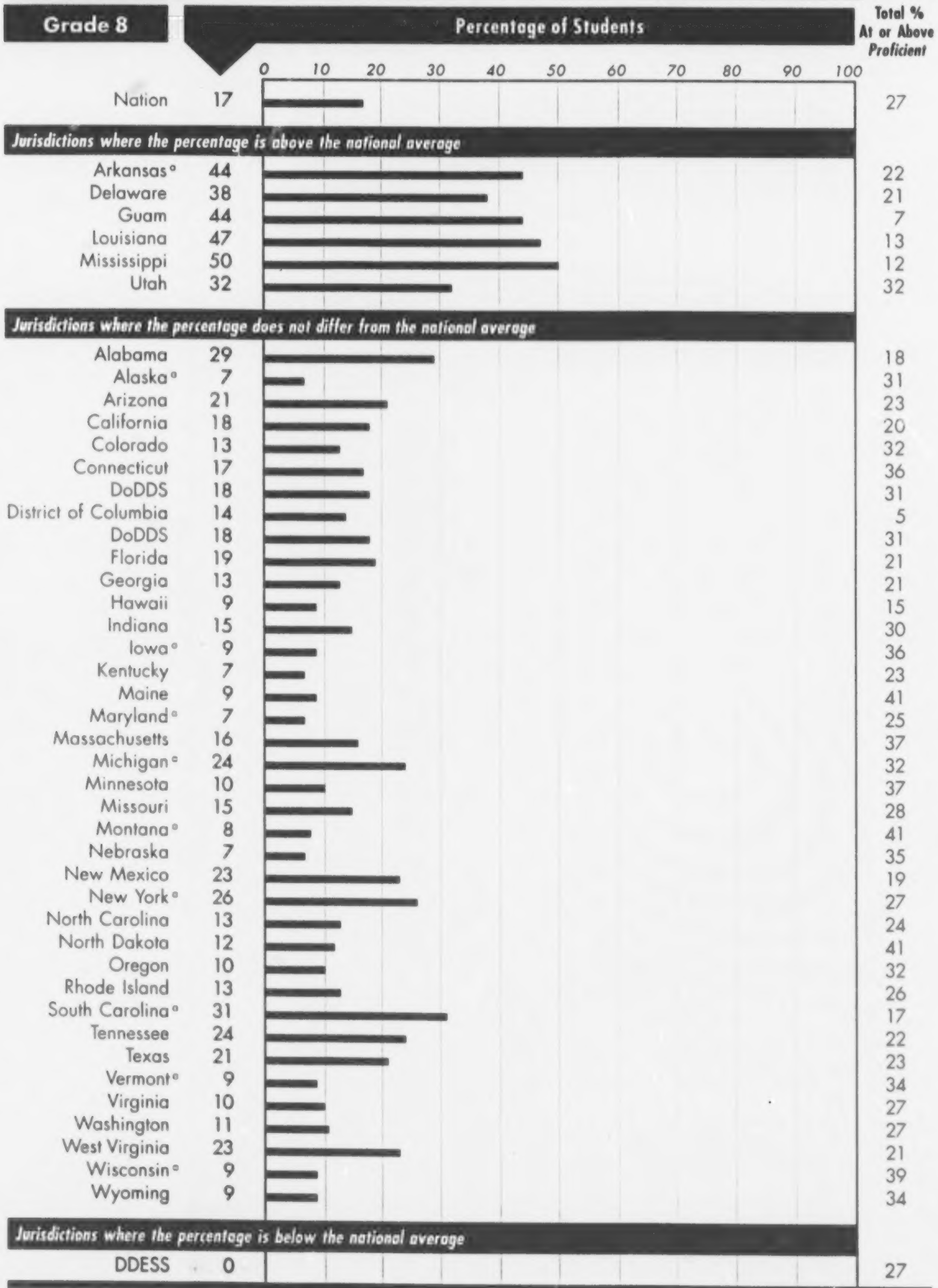
° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE 5.3

Teachers' Reports on No Availability of Computers for Use by Their Science Students, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep



Grade 8	Percentage of Students	Total % At or Above Proficient
Nation	17	27
Jurisdictions where the percentage is above the national average		
Arkansas°	44	22
Delaware	38	21
Guam	44	7
Louisiana	47	13
Mississippi	50	12
Utah	32	32
Jurisdictions where the percentage does not differ from the national average		
Alabama	29	18
Alaska°	7	31
Arizona	21	23
California	18	20
Colorado	13	32
Connecticut	17	36
DoDDS	18	31
District of Columbia	14	5
DoDDS	18	31
Florida	19	21
Georgia	13	21
Hawaii	9	15
Indiana	15	30
Iowa°	9	36
Kentucky	7	23
Maine	9	41
Maryland°	7	25
Massachusetts	16	37
Michigan°	24	32
Minnesota	10	37
Missouri	15	28
Montana°	8	41
Nebraska	7	35
New Mexico	23	19
New York°	26	27
North Carolina	13	24
North Dakota	12	41
Oregon	10	32
Rhode Island	13	26
South Carolina°	31	17
Tennessee	24	22
Texas	21	23
Vermont°	9	34
Virginia	10	27
Washington	11	27
West Virginia	23	21
Wisconsin°	9	39
Wyoming	9	34
Jurisdictions where the percentage is below the national average		
DDESS	0	27

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

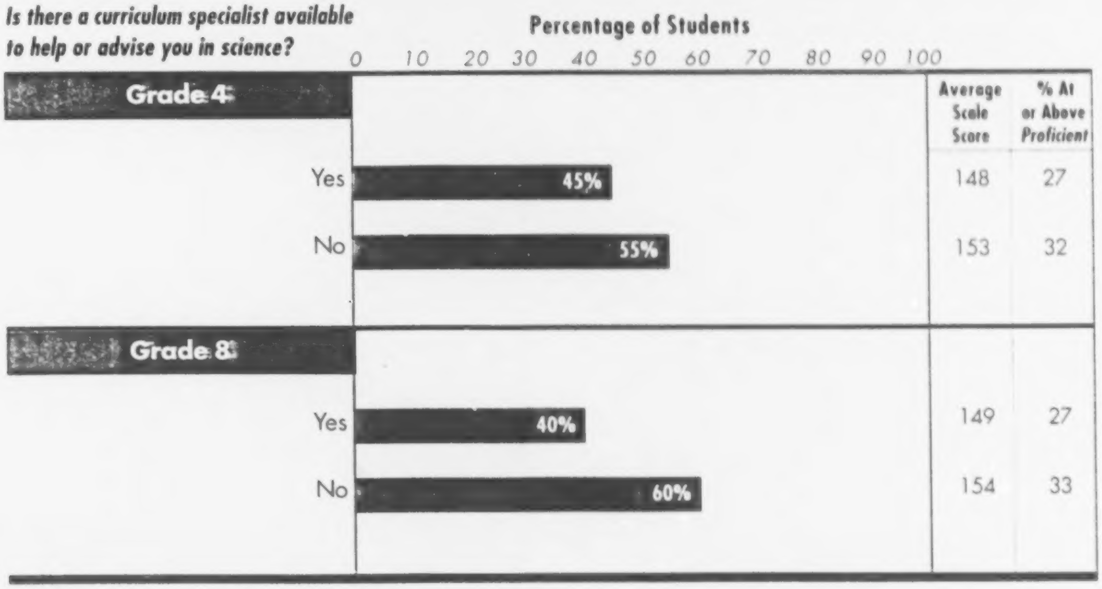
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Teachers' Reports on the Availability of Curriculum Specialists

In many schools across the nation, curriculum specialists are available to help and advise teachers. The role of curriculum specialists differs among schools and districts but can vary from developing curricula to conducting workshops to working individually with teachers. Thus, curriculum specialists can be an important resource for teachers trying to stay abreast of rapid changes in science instruction. As part of the NAEP 1996 science assessment, teachers of students in grades 4 and 8 were asked whether a curriculum specialist was available to help or advise them in science. The results are shown in Figure 5.4. Teachers of 45 percent of fourth graders and 40 percent of eighth graders reported the availability of a curriculum specialist to help or advise them. By comparison, teachers of 43 percent of fourth graders and 49 percent of eighth graders reported that mathematics curriculum specialists were available.[7] Students in grade 4 whose teachers reported the presence of a curriculum specialist in science had lower scale scores than students whose teachers reported not having a specialist available. Achievement level data showed similar results. No differences in performance were seen at the eighth-grade level.

FIGURE 5.4 **Teachers' Reports on Availability of a Curriculum Specialist in Science: Public and Nonpublic Schools Combined**

THE NATION'S REPORT CARD naep



	Percentage of Students	Average Scale Score	% At or Above Proficient
Grade 4			
Yes	45%	148	27
No	55%	153	32
Grade 8			
Yes	40%	149	27
No	60%	154	33

NOTE: Numbers may not add up to 100 due to rounding.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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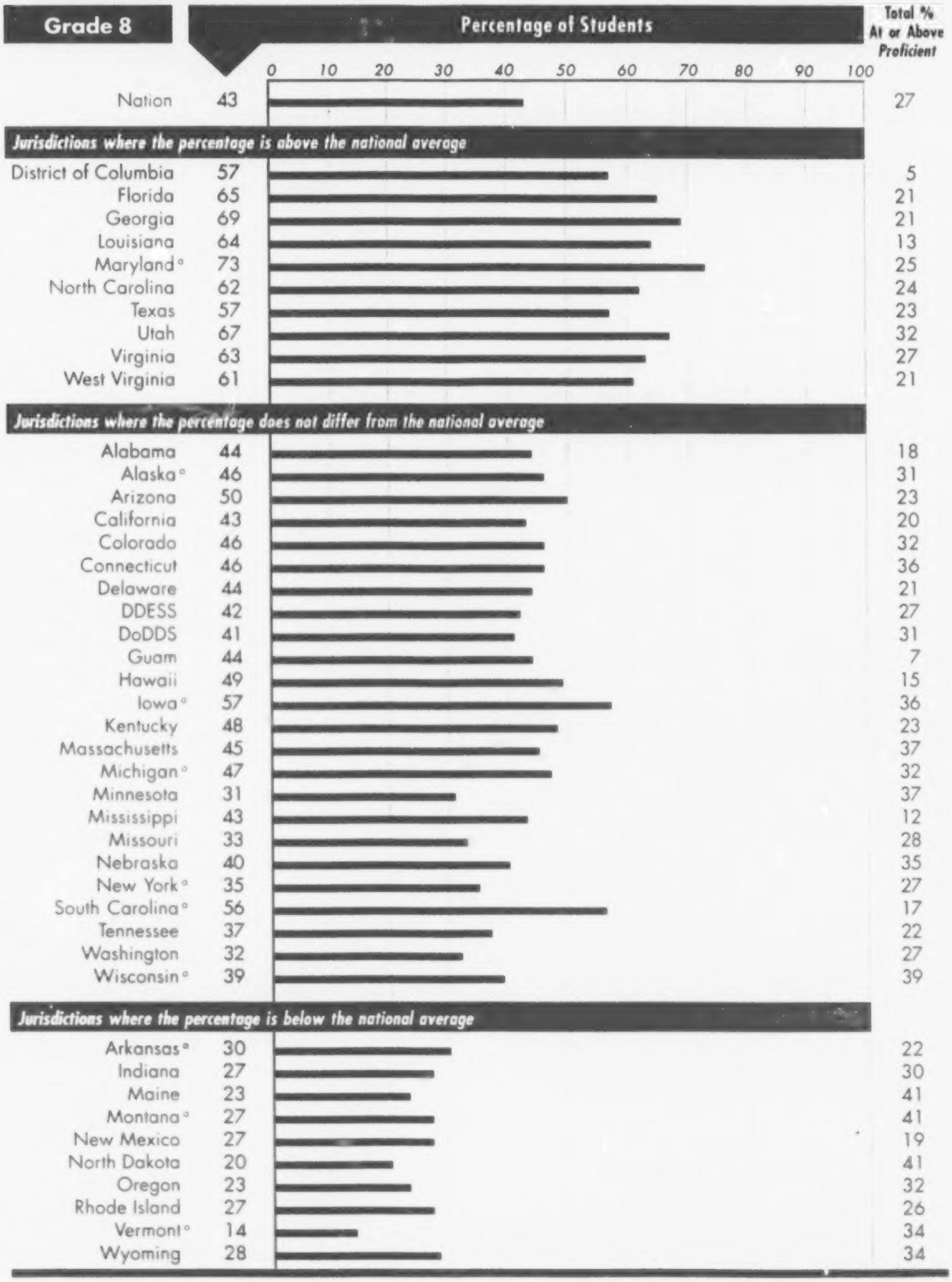
[7] National Center for Education Statistics, National Assessment of Educational Progress (1997). *1996 Mathematics Assessment Summary Data Tables* [On-line]. Available: http://nces.ed.gov/naep/tables96/index.shtml.

Figure 5.5 summarizes the jurisdiction data for public schools only. Nationally, 43 percent of eighth-grade public school students had teachers who affirmed that there was a curriculum specialist available to help or advise them in science instruction. Twenty-four jurisdictions had percentages that did not differ significantly from the nation's. Ten jurisdictions had percentages that were significantly lower than the national average. Ten jurisdictions were significantly higher than the national average.

FIGURE 5.5

Teachers' Reports on Availability of a Curriculum Specialist in Science, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep



Grade 8	Percentage of Students	Total % At or Above Proficient
Nation	43	27
Jurisdictions where the percentage is above the national average		
District of Columbia	57	5
Florida	65	21
Georgia	69	21
Louisiana	64	13
Maryland°	73	25
North Carolina	62	24
Texas	57	23
Utah	67	32
Virginia	63	27
West Virginia	61	21
Jurisdictions where the percentage does not differ from the national average		
Alabama	44	18
Alaska°	46	31
Arizona	50	23
California	43	20
Colorado	46	32
Connecticut	46	36
Delaware	44	21
DDESS	42	27
DoDDS	41	31
Guam	44	7
Hawaii	49	15
Iowa°	57	36
Kentucky	48	23
Massachusetts	45	37
Michigan°	47	32
Minnesota	31	37
Mississippi	43	12
Missouri	33	28
Nebraska	40	35
New York°	35	27
South Carolina°	56	17
Tennessee	37	22
Washington	32	27
Wisconsin°	39	39
Jurisdictions where the percentage is below the national average		
Arkansas°	30	22
Indiana	27	30
Maine	23	41
Montana°	27	41
New Mexico	27	19
North Dakota	20	41
Oregon	23	32
Rhode Island	27	26
Vermont°	14	34
Wyoming	28	34

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

The Availability of Laboratories or Appropriate Classrooms for Science Instruction

Hands-on experiences are an integral part of science education.[8] While such activities can take place in a regular classroom, the presence of dedicated laboratory space may allow students to conduct more sophisticated and long-term investigations. Teachers of assessed students at grades 4 and 8 were asked to describe the space available to them for teaching science. The results presented in Figure 5.6 reveal that nearly all fourth graders were taught science in classrooms; only 6 percent had access to a laboratory. Two-thirds had access to a water source in their classrooms, but 29 percent did not. Among eighth graders, 45 percent were taught science in laboratories and an additional 15 percent were taught in classrooms with access to a laboratory. Still, 26 percent were taught in classrooms with access to water only and 14 percent were taught in classrooms with no access to a laboratory or a water source. The access of eighth graders to laboratories may be due to the presence of laboratories within middle/junior high schools. It may also be attributed to the fact that many eighth graders attend schools that also include high school students. In such schools, laboratories are often part of the core facilities. Several associations were found between the performance of eighth-grade students and their teachers' reports of what space was available for teaching science. Students who were taught science in classrooms with no access to either a laboratory or water source had lower scale scores than students who did have access to these facilities. In addition students who had access to a laboratory had higher scale scores than students who were taught in a classroom with access to water only. Furthermore, the percentage of eighth-grade students at or above *Proficient* was significantly higher for those students whose teachers indicated that they taught science in a classroom with access to a laboratory only or a laboratory with a water source than for those students whose teachers reported teaching science in a classroom with no access to a laboratory or water source. No associations were apparent at the fourth-grade level.

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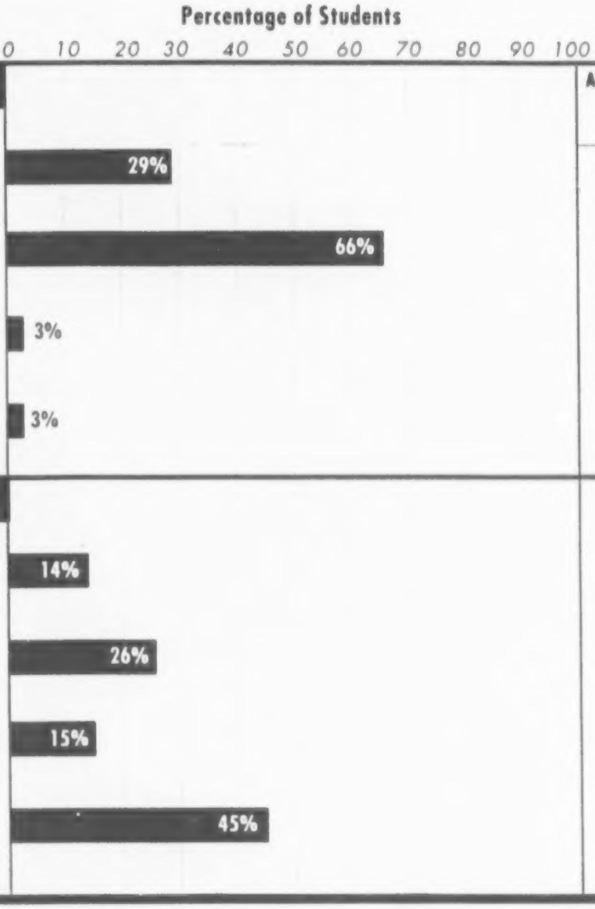
[8] American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. Washington, DC: Author. National Research Council of the Academy of Sciences. (1995). *National science education standards*. Washington, DC: Author.

FIGURE 5.6

Teachers' Reports on What Space is Available for Teaching Science: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

Which of the following best describes the space where this class is taught?



	Percentage of Students	Average Scale Score	% At or Above Proficient
Grade 4			
Classroom with no access to laboratory or water source	29%	149	29
Classroom with access to water source only	66%	151	29
Classroom with access to laboratory only	3%	153	35
A laboratory with water source	3%	161	38
Grade 8			
Classroom with no access to laboratory or water source	14%	139	19
Classroom with access to water source only	26%	149	28
Classroom with access to laboratory only	15%	164	43
A laboratory with water source	45%	154	33

NOTE: Numbers may not add up to 100 due to rounding.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

Summary

Grade 4

- Teachers of 59 percent of students reported receiving all or most of the resources they needed.
- Fifteen percent of students had no access to computers, 53 percent had one or more computers in their classrooms, and 32 percent had computer laboratories available, although for about half of the latter students the laboratories were difficult to access.
- Teachers of 45 percent of students reported having a curriculum specialist available.
- Three percent of students had access to a laboratory with a water source and two-thirds were taught science in classrooms with access to a water source.

Grade 8

- Teachers of 65 percent of students reported receiving all or most of the resources they needed.
- Among individual jurisdictions, the availability of resources varied from a low of 8 percent of students having teachers who reported receiving all or most of the resources they needed (District of Columbia) to a high of 80 percent (Nebraska).
- In the District of Columbia and Louisiana, 13 percent and 10 percent of students, respectively, had teachers who reported receiving none of the resources and instructional materials they needed.
- Sixteen percent of students had no access to computers, 38 percent had one or more computers in classrooms, and 46 percent had computer laboratories available, although for about two-thirds of the latter students the laboratories were difficult to access.
- Teachers of 40 percent of students reported having a curriculum specialist available.
- Forty-five percent of students had access to a laboratory with a water source.
- The performance of students who were taught science in a classroom with access to a laboratory or in a laboratory was higher than the performance of their counterparts who were taught science in a classroom with no access to water.

Appendix A

Overview of Procedures Used for the NAEP 1996 Science Assessment

Conducting a large-scale assessment such as the National Assessment of Educational Progress (NAEP) entails the successful coordination of numerous projects, committees, procedures, and tasks. This appendix provides an overview of the NAEP 1996 science assessment's primary components: framework, instrument development, administration, scoring, and analysis. A more extensive review of the procedures and methods used in the science assessment is included in two technical reports: the *Technical Report of the NAEP 1996 State Assessment Program in Science* and the *NAEP 1996 Technical Report.*[1]

The Science Framework

The science framework for the 1996 National Assessment of Educational Progress was produced under the auspices of the National Assessment Governing Board through a consensus process managed by the Council of Chief State School Officers, which worked with the National Center for Improving Science Education and the American Institutes for Research.[2] The framework was developed over a 10-month period between October 1990 and August 1991. The following factors guided the process for developing consensus on the science framework:

- The active participation of individuals such as curriculum specialists, science teachers, science supervisors, state assessment developers, administrators, individuals from business and industry, government officials, and parents;
- The representation of what is considered essential learning in science, and the recommendation of innovative assessment techniques to probe the critical abilities and content areas; and

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[1] Allen, N. L., Swinton, S. S., Isham, S. P., & Zelenak, C. A. (1997). *Technical report of the NAEP 1996 state assessment program in science* (Publication No. NCES 98-480). Washington, DC: National Center for Education Statistics.

Allen, N.L., Carlson, J., & Zelenak, C. A. (1998). *NAEP 1996 technical report* (Publication No. NCES 98-479). Washington, DC: National Center for Education Statistics. Report in preparation.

[2] National Assessment Governing Board. (1995). *Science framework for the 1996 National Assessment of Educational Progress.* Washington, DC: Author.

- The recognition of the lack of agreement on a common scope of instruction and sequence, components of scientific literacy, important outcomes of learning, and the nature of overarching themes in science.

While maintaining some conceptual continuity with the NAEP 1990 science assessment framework, the 1996 framework acknowledges some of the reforms currently taking place in science education as well as documents such as the science framework used for the 1991 International Assessment of Educational Progress. In addition, the Framework Steering Committee recommended that a variety of strategies be used for assessing students' performance. These included:

- Multiple-choice questions that assess students' knowledge of important facts and concepts and that probe their analytical reasoning skills;
- Constructed-response questions that explore students' abilities to explain, integrate, apply, reason about, plan, design, evaluate, and communicate science information, and
- Hands-on tasks that probe students' abilities to use materials to make observations, perform investigations, evaluate experimental results, and apply problem-solving skills.

The framework for the 1996 science assessment is represented as a matrix with two dimensions represented by three fields of science (earth, physical, and life) and three elements of knowing and doing science (conceptual understanding, scientific investigation, and practical reasoning). In addition, there are two overarching domains that describe science, the nature of science, and themes. Figures A.1a, A.1b, and A.1c describe, respectively, the fields of science, the elements of knowing and doing, and the overarching domains that guided the development of the 1996 science assessment.

FIGURE A.1a

Descriptions of the Three Fields of Science

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Earth Science

The earth science content assessment centers on objects and events that are relatively accessible or visible. The concepts and topics covered are solid Earth (lithosphere), water (hydrosphere), air (atmosphere), and Earth in space. The solid Earth consists of composition; forces that alter its surface; the formation, characteristics and uses of rocks; the changes and uses of soil; natural resources used by humankind; and natural forces within Earth (not at grade 4). Concepts and topics related to water consist of the water cycle; the nature of oceans and their effects; and the location of water, its distribution, characteristics, and effect of and influence on human activity. Air is broken down into composition and structure of the atmosphere (including energy transfer); the nature of weather; climate (not at grade 4) and interactions of human society with atmosphere. Earth in space consists of the setting of Earth in the solar system; the setting and evolution of the solar system in the universe (not at grade 4); tools and technology that are used to gather information about space; apparent daily motions of the Sun, the Moon, the planets and the stars; rotation of Earth about its axis, and Earth's revolution around the Sun; the tilt of Earth's axis that produces seasonal variations in the climate; and Earth history.

Physical Science

The physical science component relates to basic knowledge and understanding concerning the structure of the universe as well as the physical principles that operate within it. The major sub-topics probed are matter and its transformations, energy and its transformations, and motion. Matter and its transformations are described by diversity of materials (classification and types and the particulate nature of matter); temperature and states of matter; properties and uses of material (modifying properties, synthesis of materials with new properties); and resource management (not at grades 4 and 8). Energy and its transformations involve different forms of energy; energy transformations in living systems, natural physical systems, and artificial systems constructed by humans; and energy sources and use, including distribution, energy conversion, and energy costs and depletion. Motion is broken down into an understanding of frames of reference; force and changes in position and motion; action and reaction (not at grade 4); vibrations and waves as motion; general wave behavior (not at grades 4 and 8); electromagnetic radiation; and the interactions of electromagnetic radiation with matter.

Life Science

The fundamental goal of life science is to attempt to understand and explain the nature and function of living things. The major concepts assessed in life science are change and evolution, cells and their functions (not at grade 4), organisms, and ecology. Change and evolution includes diversity of life on Earth; genetic variation within a species; theories of adaptation and natural selection; and changes in diversity over time (not at grades 4 and 8). Cells and their functions consists of information transfer; energy transfer for the construction of proteins; and communication among cells. Organisms are described by reproduction, growth and development; life cycles; and functions and interactions of systems within organisms.The topic of ecology centers on the interdependence of life—populations, communities, and ecosystems.

SOURCE: *Science Framework for the 1996 National Assessment of Educational Progress.* (Washington, DC: National Assessment Governing Board, 1995).

FIGURE A.1b

Descriptions of Knowing and Doing Science

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Conceptual Understanding

Conceptual understanding includes the body of scientific knowledge that students draw upon when conducting a scientific investigation or engaging in practical reasoning. Essential scientific concepts involve a variety of information including facts and events the student learns from science instruction and experiences with the natural environment and scientific concepts, principles, laws, and theories that scientists use to explain and predict observations of the natural world.

Scientific Investigation

Scientific investigation probes students' abilities to use the tools of science, including both cognitive and laboratory tools. Students should be able to acquire new information, plan appropriate investigations, use a variety of scientific tools, and communicate the results of their investigations.

Practical Reasoning

Practical reasoning probes students' ability to use and apply science understanding in new, real-world applications.

SOURCE: *Science Framework for the 1996 National Assessment of Educational Progress.* (Washington, DC: National Assessment Governing Board, 1995).

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FIGURE A.1c *Description of Overarching Domains*

The Nature of Science

The nature of science incorporates the historical development of science and technology, the habits of mind that characterize these fields, and methods of inquiry and problem-solving. It also encompasses the nature of technology that includes issues of design, application of science to real-world problems, and trade-offs or compromises that need to be made.

Themes

Themes are the "big ideas" of science that transcend the various scientific disciplines and enable students to consider problems with global implications. The NAEP science assessment focuses on three themes: systems, models, and patterns of change.

- Systems are complete, predictable cycles, structures or processes occurring in natural phenomena. Students should understand that a system is an artificial construction created to represent, or explain a natural occurrence. Students should be able to identify and define the system boundaries, identify the components and their interrelationships and note the inputs and outputs to the system.
- Models of objects and events in nature are ways to understand complex or abstract phenomena. As such they have limits and involve simplifying assumptions but also possess generalizability and often predictive power. Students need to be able to distinguish the idealized model from the phenomenon itself and to understand the limitations and simplified assumptions that underlie scientific models.
- Patterns of change involve students' recognition of patterns of similarity and differences, and recognize how these patterns change over time. In addition, students should have a store of common types of patterns and transfer their understanding of a familiar pattern of change to a new and unfamiliar one.

SOURCE: *Science Framework for the 1996 National Assessment of Educational Progress.* (Washington, DC: National Assessment Governing Board, 1995).

The Assessment Design

Each student in the assessment received a booklet comprised of six sections. Three of these sections were blocks of cognitive questions that assessed the knowledge and skills outlined in the framework.[3] The other three sections were sets of background questions. Two of the three cognitive sections contained only paper-and-pencil questions, and the third section consisted of a hands-on task with related paper-and-pencil questions. Students at grades 8 and 12 were allowed 30 minutes to complete each cognitive section, while students at grade 4 were given cognitive blocks that required only 20 minutes to complete.

At each grade level there were 15 different sections, or blocks, of cognitive questions, usually consisting of both multiple-choice and constructed-response questions. Short constructed-response questions required a few words or a sentence or two for an answer (e.g., briefly stating how nutrients move from the digestive system to the tissues) while extended constructed-response questions generally required a paragraph or more (e.g., outlining an experiment to test the effect of increasing the amount of available food on the rate of increase of the *Hydra* population). Some extended constructed-response questions also required diagrams, graphs, or calculations. It was expected that students could adequately answer the short constructed-response questions in about two to three minutes and the extended constructed-response questions in about five minutes.

Other features were built into the blocks of questions. Four of the blocks at each grade level presented hands-on tasks in which students were given a set of equipment and asked to conduct an investigation and answer questions related to the investigation. Every student conducted a hands-on task, which was always presented in the third cognitive section. A second feature was the inclusion of theme blocks at each grade level — one assessing systems, one assessing models, and one assessing patterns of change. For example, students were shown a simplified model of part of the solar system, with a brief description, and then asked a number of questions based on that information. Theme blocks were placed randomly in the student booklets. Not every booklet contained one and no booklet contained more than one.

The data in Table A.1 reflect the number of cognitive questions by type and by grade level for the 1996 assessment. The assessment pool contained 443 unique questions: 165 multiple-choice (MC), 219 short constructed-response (SCR), and 59 extended constructed-response (ECR). Some of these questions were used at more than one grade level; as a result, the sum of the questions that appear at each grade level is greater than the total number of unique questions.

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[3] "Blocks" are collections of questions grouped, in part, according to the amount of time required to answer them.

TABLE A.1 **Distribution of Questions by Type**

	Grade 4			Grade 8			Grade 12		
	MC[1]	SCR[2]	ECR[3]	MC[1]	SCR[2]	ECR[3]	MC[1]	SCR[2]	ECR[3]
Grade 4 Only	42	57	12						
Grades 4 & 8 Overlap	9	16	4	9	16	4			
Grade 8 Only				44	58	13			
Grades 8 & 12 Overlap				21	26	3	21	26	3
Grade 12 Only							49	62	27
TOTAL by Grade	51	73	16	74	100	20	70	88	30

[1] Multiple-choice questions
[2] Short constructed-response questions
[3] Extended constructed-response questions
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

On the basis of information gathered from the field test, the booklets were carefully constructed to balance time requirements for the question types in each block. More information on the design of the assessment is presented in the forthcoming *NAEP 1996 Technical Report.*[1]

The Background Questionnaires

As part of the national NAEP 1996 science assessment, approximately 2,500 teachers responsible for teaching science to students who participated in the fourth- and eighth-grade assessments responded to a questionnaire, as did approximately 9,000 teachers of eighth-grade students who participated in state NAEP. The questionnaires were composed of three sections. One section contained questions about teachers' general background and experience. The second asked about teachers' science preparation, and the third focused on science instructional practices. Teacher sampling for the teacher questionnaires was based on participating students, hence the responses do not necessarily represent all fourth- and eighth-grade teachers in the nation. Rather, they represent teachers of a representative sample of students in the assessment. Consequently, the findings portray the nature of students' instructional experiences and the backgrounds of their teachers. There was no background teacher questionnaire at grade 12 because approximately half of the students that participated in the NAEP science assessment were not enrolled in a science course and thus could not be linked to any teacher.

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[1] Allen, N.L., Carlson, J., & Zelenak, C. A. (1998). *NAEP 1996 technical report* (Publication No. NCES 98-479). Washington, DC: National Center for Education Statistics. Report in preparation.

Approximately 1,800 principals or other administrators of sampled schools at grades 4, 8, and 12 completed a school questionnaire for the main NAEP study. In addition, 4,300 principals or other public school administrators completed questionnaires for state NAEP. Each of the grade-specific questionnaires focused on five areas: instructional content, instructional practices and experiences, teacher characteristics, school conditions and contexts, and conditions outside the school (i.e., home support, out-of-school activities, and attitudes).

Approximately 35,000 students in grades 4, 8, and 12 in main NAEP and 113,000 students in state NAEP responded to three sets of background questions in addition to science cognitive exercises. The background questions probed students' general backgrounds, their science experiences, and their motivations.

It is important to note that in this report, as in all NAEP reports, the student is the unit of analysis, even when information from teacher or school questionnaires is reported. This is because the sampling for the teacher and school questionnaires was based on participating students and does not represent all teachers or schools in the nation or in a state. For example, when discussing the educational background of science teachers, NAEP can report that 45 percent of eighth-grade students were taught science by teachers who reported having an undergraduate or graduate major in science but cannot report that 45 percent of all the nation's teachers have an undergraduate or graduate major in science.

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National and State Samples

Results presented in this report are based on nationally representative probability samples of fourth-, eighth-, and twelfth-grade students. The samples were selected using a complex multistage sampling design that involved sampling students from selected schools within selected geographic areas across the country. The sample design had the following stages:

1. Selection of geographic areas (a county, group of counties, or metropolitan statistical area)
2. Selection of schools (public and nonpublic) within the selected areas
3. Selection of students within the selected schools

Each selected school that participated in the assessment and each student assessed represents a portion of the population of interest. Sampling weights are needed to make valid inferences between the student samples and the respective populations from which they were drawn. In addition, NAEP oversamples nonpublic schools and schools in which more than 15 percent of the student population is non-White. Sampling weights adjust for disproportionate representation due to such oversampling.

Table A.2 provides a summary of the weighted and unweighted student sample sizes for the national NAEP 1996 science assessment. The numbers reported include public and nonpublic school students.

Table A.2

National School and Student Sample Sizes for the NAEP 1996 Science Assessment

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	Number of Schools	Unweighted Student Sample Size	Weighted Student Sample Size
Grade 4	237	7,305	3,621,677
Grade 8	202	7,774	3,568,034
Grade 12	232	7,537	2,907,065

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

The results of the 1996 state assessment program in science provided in this report are based on state-level samples of eighth-grade students. The samples of both public and nonpublic school eighth-grade students were selected based on a two-stage sample design that entailed selecting schools within participating jurisdictions and selecting students within schools. The first-stage samples of schools were selected with a probability proportional to the eighth-grade enrollment in those schools. Special procedures were used both for jurisdictions that had many small schools and for jurisdictions that had a small number of schools. In addition, each jurisdiction was provided with a list of substitute schools. For each sampled school, a substitute school was designated that matched as closely as possible the characteristics of the sampled school. States were permitted to replace a sampled school that declined participation with its designated substitute school.

As with the national samples, the jurisdiction samples were weighted to allow for valid inferences about the populations of interest. Tables A.3a and A.3b contain, for public and nonpublic schools respectively, the unweighted numbers of participating schools and students as well as weighted school and student participation rates. Two weighted school participation rates are provided for each jurisdiction. The first rate is the weighted percentage of schools participating in the assessment before substitution. This rate is based only on the number of schools that were initially selected for the assessment. The numerator of this rate is the sum of the number of students represented by each initially selected school that participated in the assessment. The denominator is the sum of the number of students represented by each of the initially selected schools that had eligible students enrolled. This rate included both participating and nonparticipating schools.

The second school participation rate is the weighted participation rate after substitution. The numerator of this rate is the sum of the number of students represented by each of the participating schools, whether originally selected or substituted. The denominator is the same as that for the weighted participation rate for the initial sample. This statement means that for a given jurisdiction, the weighted participation rate after substitution is at least as great as the weighted participation rate before substitution.

Also presented in Tables A.3a and A.3b are the weighted percentages of students who participated after makeup sessions were completed. This rate reflects the percentage of the eligible student population from participating schools within the jurisdiction, and this percentage represents the students who participated in the assessment in either an initial session or a makeup session. The numerator of this rate is the sum, across all assessed students, of the number of students represented by each selected student who was eligible to participate, including those students who did not participate.

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Table A.3a

NAEP 1996 School and Student Participation Rates, for the Nation and Jurisdictions: Public Schools Only

Grade 8	Weighted School Participation Rate: Before Substitutes	Weighted School Participation Rate: After Substitutes	Total Number of Schools Participating	Weighted Student Participation Rate	Total Number of Students Assessed
Nation	80	80	128	93	6,376
Alabama	84	90	96	93	2,186
Alaska ‡	93	93	55	82	1,517
Arizona	87	87	94	90	2,151
Arkansas ‡	70	71	76	92	1,858
California	83	94	101	92	2,292
Colorado	100	100	108	91	2,514
Connecticut	100	100	102	93	2,489
Delaware	100	100	30	89	1,903
District of Columbia	100	100	33	85	1,700
DDESS	100	100	11	95	602
DoDDS	100	100	58	93	2,223
Florida	100	100	105	90	2,353
Georgia	99	99	100	92	2,470
Guam	100	100	6	90	930
Hawaii	100	100	51	90	2,153
Indiana	87	90	96	92	2,313
Iowa ‡	73	83	91	94	2,172
Kentucky	87	92	100	94	2,459
Louisiana	100	100	111	90	2,615
Maine	91	91	95	92	2,254
Maryland ‡	86	86	89	89	2,092
Massachusetts	92	92	98	91	2,287
Michigan ‡	70	87	92	90	2,186
Minnesota	86	88	95	92	2,383
Mississippi	89	95	103	92	2,469
Missouri	93	96	105	92	2,389
Montana ‡	70	76	79	92	2,029
Nebraska	99	100	120	92	2,724
Nevada ‡	37	38	28	92	964
New Hampshire ‡	66	68	64	90	1,710
New Jersey ‡	63	64	67	93	1,573
New Mexico	100	100	90	90	2,377
New York ‡	70	78	82	90	1,876
North Carolina	100	100	107	91	2,616
North Dakota	80	93	108	94	2,489
Oregon	86	92	100	89	2,275
Rhode Island	90	90	43	89	2,087
South Carolina ‡	86	87	91	90	2,162
Tennessee	92	92	99	91	2,287
Texas	91	96	102	92	2,300
Utah	100	100	94	90	2,715
Vermont ‡	74	75	78	93	1,914
Virginia	100	100	106	90	2,552
Washington	94	95	105	90	2,501
West Virginia	100	100	105	93	2,602
Wisconsin ‡	78	78	90	90	2,148
Wyoming	100	100	67	93	2,619

National results are based on the national assessment sample, not on aggregated state assessment program samples.

‡ Indicates that the jurisdiction did not satisfy one or more of the guidelines for public school participation rates, see O'Sullivan, C. Y., Reese, C. M., & Mazzeo, J. (1997). *NAEP 1996 science report card for the nation and the states: Findings from the National Assessment of Educational Progress* (Publication No. NCES 97-499). Washington, DC: National Center for Education Statistics.

DDESS: Department of Defense Domestic Dependent Elementary and Secondary Schools

DoDDS: Department of Defense Dependents Schools (Overseas)

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment

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Table A.3b

NAEP 1996 School and Student Participation Rates, for the Nation and Jurisdictions: Nonpublic Schools Only

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Grade 8	Weighted School Participation Rate		Total Number of Schools Participating	Weighted Student Participation Rate	Total Number of Students Assessed
	Before Substitutes	After Substitutes			
Nation	77	77	81	97	1,398
Alabama ‡	60	60	10	95	144
Arkansas ‡	74	74	6	99	89
California ‡	80	80	14	96	206
Connecticut ‡	63	65	20	96	263
Delaware ‡	42	44	13	96	313
District of Columbia ‡	52	52	19	95	259
Georgia	88	88	9	96	232
Guam ‡	79	79	8	94	198
Iowa	94	94	14	96	246
Kentucky ‡	82	82	13	97	260
Louisiana ‡	75	75	21	96	424
Maryland ‡	61	64	19	94	322
Massachusetts ‡	75	77	21	94	335
Michigan ‡	80	87	21	97	332
Minnesota ‡	84	84	19	94	247
Missouri	94	100	24	95	365
Montana	93	97	13	93	154
Nebraska ‡	78	84	20	96	333
Nevada	90	90	8	91	133
New Hampshire ‡	83	83	12	95	179
New Jersey ‡	62	64	20	96	287
New Mexico	95	95	13	95	230
New York ‡	84	87	28	97	514
North Dakota ‡	70	78	10	93	160
Oregon ‡	26	26	4	86	54
Rhode Island ‡	68	68	22	96	340
South Carolina ‡	69	69	8	95	138
Texas ‡	79	79	7	98	130
Utah ‡	64	64	4	93	93
Vermont ‡	72	80	10	91	115
Washington	86	86	11	95	215
Wisconsin ‡	65	69	27	96	380
Wyoming ‡	92	92	6	94	47

National results are based on the national assessment sample, not on aggregated state assessment program samples.

‡ Indicates that the jurisdiction did not satisfy one or more of the guidelines for nonpublic school participation rates, see O'Sullivan, C. Y., Reese, C. M., & Mazzeo, J. (1997). *NAEP 1996 science report card for the nation and the states: Findings from the National Assessment of Educational Progress* (Publication No. NCES 97-499). Washington, DC: National Center for Education Statistics.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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Data Collection and Scoring

Data collection for the main NAEP assessment was conducted by trained field staff at Westat, the NAEP grantee for data collection. For the state component of the assessment, data were collected by local school personnel trained by Westat representatives. Materials from the assessment were shipped to National Computer Systems, where trained staff evaluated the responses to the constructed-response questions using scoring rubrics or guides prepared by Educational Testing Service (ETS). Each constructed-response question had a unique scoring guide that defined the criteria used to evaluate students' responses. The extended constructed-response questions were evaluated with four- or five-level guides, while the short constructed-response questions were rated according to two- or three-level guides. For the national and state science assessments, more than 4.1 million constructed responses were scored. This number includes rescoring to monitor interrater reliability. The overall percentages of agreement for the 1996 national reliability samples were 94 percent at grade 4, 94 percent at grade 8, and 93 percent at grade 12.

Data Analysis and IRT Scaling of Student Responses

Subsequent to the professional scoring, all information was transcribed to the NAEP database at ETS. Each processing activity was conducted with rigorous quality control. After the assessment information had been compiled in the database, the data were weighted according to the population structure. The weighting for the national and state samples reflected the probability of selection for each student as a result of the sampling design, adjusted for nonresponse. Through stratification, the weighting assured that the representation of certain subpopulations corresponded to figures from the U.S. Census and the Current Population Survey.[5]

Analyses were then conducted to determine the percentages of students that gave various responses to each cognitive and background question.

Item Response Theory (IRT) was used to estimate average science scale scores for the nation, for various subgroups of interest within the nation, and for the jurisdictions. IRT models the probability of answering a question in a certain way as a mathematical function of proficiency or skill. The main purpose of IRT analysis is to provide a common scale on which performance can be compared across groups, for example, those defined by characteristics such as gender and race/ethnicity.

Because of the balanced incomplete block (BIB) spiraling design used by NAEP, students do not receive enough questions about a specific topic to provide reliable information about individual performance. Traditional test scores for individual students, even those based on IRT, would lead to misleading estimates of population characteristics, such as subgroup means and percentages of students at or above a certain scale score level. Consequently, NAEP constructs sets of plausible values designed to represent the distribution of performance in the population. A plausible value for an individual is not a scale score for that individual but may be regarded as a representative value from the distribution of potential scale scores for all students in the population with similar characteristics and identical patterns of item response. Statistics describing performance on the NAEP science scale are based on the plausible values. They estimate values that would have been obtained had individual scale scores been observed, that is, had each student responded to a sufficient number of cognitive questions so that his or her individual scores could be precisely estimated.[6]

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[5] For additional information about the use of weighting procedures in NAEP, see Johnson, E. G. (1989). Considerations and techniques for the analysis of NAEP data. *Journal of Educational Statistics, 14*, 303-334.

At each grade, three distinct 0-to-300 scales were created to summarize students' abilities in the three defined fields of science: earth, physical, and life. The scales summarize student performance across all three question types in the assessment (multiple-choice, short constructed-response, and extended constructed-response). For each grade, the mean for each field of science was set at 150 and the standard deviation at 35. Constraining the mean and standard deviation of the scales to 150 and 35 also constrained, to some degree, the locations of the percentiles for the total group of students at each grade. However, within-grade comparisons of percentiles across subgroups still provide valuable comparative information. The reporting metric was developed using data from the national assessment program, and the results for the state assessment program were linked to these scales. Because the assessment was developed using a new framework it was not appropriate to compare or link the results from the 1996 assessments to previous NAEP science assessments.

In addition to the plausible values for each scale, a composite of the three fields of science scales was created as a measure of overall science performance. This composite was a weighted average of the plausible values for the three science scales, in which the weights were proportional to the relative importance assigned to each field of science in the assessment framework. More detailed information about data analysis and items are presented in the *1996 NAEP Technical Report*.[7]

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[6] For theoretical and empirical justification of the procedures employed, see Mislevy, R. J (1991). Randomization-based inferences about latent variables from complex samples. *Psychometrika*, *56*(2), pp. 177-196.

For computational details, see E. G. Johnson & R. Zwick (Eds.), *Focusing the new design: The NAEP 1988 technical report* (pp. 267-296). Washington, DC: National Center for Education Statistics, and Johnson, E. G., & Allen, N. L. (1992). *The NAEP 1990 technical report* (No. 21-TR-20). Princeton, NJ: Educational Testing Service, National Assessment of Educational Progress.

[7] Allen, N. L., Carlson, J. E., & Zelenak, C. A. (1998). *The NAEP 1996 technical report* (Publication No. NCES 98-479). Washington, DC: National Center for Education Statistics. Report in preparation.

NAEP Reporting Groups

In this report, some of the results for students in grades 4, 8, and 12 are also provided for separate subpopulations of students who participated in the state component of the science assessment. The national sample is independent of the state samples and not an aggregation of them. In any given analysis, results are reported only for subpopulations represented by sufficient numbers of students and adequate school distributions. For public school students, the minimum requirement is at least 62 students in a particular subgroup from at least five Primary Sampling Units (PSUs).[8] For nonpublic school students, the minimum requirement is 62 students from at least six schools for the state assessment program or from at least five PSUs for the national assessment.

In the case of all state results presented in this report, many of the samples of nonpublic school students were not large enough to permit the separate reporting of nonpublic school results or the combined reporting of public and nonpublic school results. Thus, only public school results are shown. However, the national data presented includes both public and nonpublic students combined.

Achievement Level Results

NAEP results are reported for student performance according to the newly defined achievement levels set by the NAGB. The results are expressed as percentages of students or percentages of selected subgroups who have reached *Basic*, *Proficient*, and *Advanced* levels. The three levels are at each grade and are cumulative in nature, that is, it is assumed that students at the *Proficient* level are likely to be successful at the *Basic* and *Proficient* levels, and that students at the *Advanced* level are likely to be successful at the *Basic*, *Proficient*, and *Advanced* levels. Results in this report are presented as percentages of students at or above the *Proficient* level. A full description of the achievement levels for each grade follows in Table A.4.

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[8] For the national assessment, a PSU is a selected geographic region (a county, a group of counties, or metropolitan statistical areas). For the state assessment program, a PSU is most often a single school.

Table A.4

1996 NAEP Science Achievement Level Descriptions: Grade 4

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Cut Score	Content Descriptions*
BASIC 138	Students performing at the *Basic* level demonstrate some of the knowledge and reasoning required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 4. For example, they can carry out simple investigations and read uncomplicated graphs and diagrams. Students at this level also show a beginning understanding of classification, simple relationships, and energy. Fourth-grade students performing at the *Basic* level are able to follow simple procedures, manipulate simple materials, make observations, and record data. They are able to read simple graphs and diagrams and draw reasonable but limited conclusions based on data provided to them. These students can recognize appropriate experimental designs, although they are unable to justify their decisions. When presented with diagrams, students at this level can identify seasons; distinguish between day and night; and place the position of the Earth, sun, and planets. They are able to recognize major energy sources and simple energy changes. In addition, they show an understanding of the relationship between sound and vibrations. These students are able to identify organisms by physical characteristics and group organisms with similar physical features. They can also describe simple relationships among structure, function, habitat, life cycles, and different organisms.
PROFICIENT 170	Students performing at the *Proficient* level demonstrate the knowledge and reasoning required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 4. For example, they understand concepts relating to the Earth's features, physical properties, and structure and function. In addition, students can formulate solutions to familiar problems as well as show a beginning awareness of issues associated with technology. Fourth-grade students performing at the *Proficient* level are able to provide an explanation of day and night when given a diagram. They can recognize major features of the Earth's surface and the impact of natural forces. They are also able to recognize water in its various forms in the water cycle and can suggest ways to conserve it. These students recognize that various materials possess different properties that make them useful. Students at this level are able to explain how structure and function help living things survive. They have a beginning awareness of the benefits and challenges associated with technology and recognize some human effects on the environment. They can also make straightforward predictions and justify their position.
ADVANCED 205	Students performing at the *Advanced* level demonstrate a solid understanding of the earth, physical, and life sciences as well as the ability to apply their understanding to practical situations at a level appropriate to Grade 4. For example, they can perform and critique simple investigations, make connections from one or more of the sciences to predict or conclude, and apply fundamental concepts to practical applications. Fourth-grade students performing at the *Advanced* level are able to combine information, data, and knowledge from one or more of the sciences to reach a conclusion or to make a valid prediction. They can also recognize, design, and explain simple experimental procedures. Students at this level recognize nonrenewable sources of energy. They also recognize that light and sound travel at different speeds. These students understand some principles of ecology and are able to compare and contrast life cycles of various common organisms. In addition, they have a developmental awareness of the benefits and challenges associated with technology.

* Shaded areas indicate summary of content descriptions.

Table A.4 continued

1996 NAEP Science Achievement Level Descriptions: Grade 8

THE NATION'S REPORT CARD naep

Cut Score	Content Descriptions*
BASIC 143	Students performing at the *Basic* level demonstrate some of the knowledge and reasoning required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 8. For example, they can carry out investigations and obtain information from graphs, diagrams, and tables. In addition, they demonstrate some understanding of concepts relating to the solar system and relative motion. Students at this level also have a beginning understanding of cause-and-effect relationships. Eighth-grade students performing at the *Basic* level are able to observe, measure, collect, record, and compute data from investigations. They can read simple graphs and tables and are able to make simple data comparisons. These students are able to follow directions and use basic science equipment to perform simple experiments. In addition, they have an emerging ability to design experiments. Students at this level have some awareness of causal relationships. They recognize the position of planets and their movement around the sun and know basic weather-related phenomena. These students can explain changes in position and motion such as the movement of a truck in relation to that of a car. They also have an emerging understanding of the interrelationships among plants, animals, and the environment.
PROFICIENT 170	Students performing at the *Proficient* level demonstrate much of the knowledge and many of the reasoning abilities essential for understanding of the earth, physical, and life sciences at a level appropriate to Grade 8. For example, students can interpret graphic information, design simple investigations, and explain such scientific concepts as energy transfer. Students at this level also show an awareness of environmental issues, especially those addressing energy and pollution. Eighth-grade students performing at the *Proficient* level are able to create, interpret, and make predictions from charts, diagrams, and graphs based on information provided to them or from their own investigations. They have the ability to design an experiment and have an emerging understanding of variables and controls. These students are able to read and interpret geographic and topographic maps. In addition, they have an emerging ability to use and understand models, can partially formulate explanations of their understanding of scientific phenomena, and can design plans to solve problems. Students at this level can begin to identify forms of energy and describe the role of energy transformations in living and nonliving systems. They have knowledge of organization, gravity, and motions within the solar system and can identify some factors that shape the surface of the Earth. These students have some understanding of properties of materials and have an emerging understanding of the particulate nature of matter, especially the effect of temperature on states of matter. They also know that light and sound travel at different speeds and can apply their knowledge of force, speed, and motion. These students demonstrate a developmental understanding of the flow of energy from the sun through living systems, especially plants. They know that organisms reproduce and that characteristics are inherited from previous generations. These students also understand that organisms are made up of cells and that cells have subcomponents with different functions. In addition, they are able to develop their own classification system based on physical characteristics. These students can list some effects of air and water pollution as well as demonstrate knowledge of the advantages and disadvantages of different energy sources in terms of how they affect the environment and the economy.

* Shaded areas indicate summary of content descriptions.

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Table A.4 continued

1996 NAEP Science Achievement Level Descriptions: Grade 8

Cut Score	Content Descriptions*
ADVANCED **208**	Students performing at the *Advanced* level demonstrate a solid understanding of the earth, physical, and life sciences as well as the abilities required to apply their understanding in practical situations at a level appropriate to Grade 8. For example, students perform and critique the design of investigations, relate scientific concepts to each other, explain their reasoning, and discuss the impact of human activities on the environment. Eighth-grade students performing at the *Advanced* level are able to provide an explanation for scientific results. They have a modest understanding of scale and are able to design a controlled experiment. These students have an understanding of models as representations of natural systems and can describe energy transfer in living and nonliving systems. Students at this level are able to understand that present physical clues, including fossils and geological formations, are indications that the Earth has not always been the same and that the present is a key to understanding the past. They have a solid knowledge of forces and motions within the solar system and an emerging understanding of atmospheric pressure. These students can recognize a wide range of physical and chemical properties of matter and some of their interactions and understand some of the properties of light and sound. Also, they can infer relationship between structure and function. These students know the differences between plant and animal cells and can apply their knowledge of food as a source of energy to a practical situation. In addition, they are able to explain the impact of human activities on the environment and the economy.

* Shaded areas indicate summary of content descriptions.

Table A.4 continued

1996 NAEP Science Achievement Level Descriptions: Grade 12

Cut Score	Content Descriptions*
BASIC 146	Students performing at the *Basic* level demonstrate some knowledge and certain reasoning abilities required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 12. In addition, they demonstrate knowledge of the themes of science (models, systems, patterns of change) required for understanding the most basic relationships among the earth, physical, and life sciences. They are able to conduct investigations, critique the design of investigations, and demonstrate a rudimentary understanding of scientific principles. Twelfth-grade students performing at the *Basic* level are able to select and use appropriate simple laboratory equipment and write down simple procedures that others can follow. They also have a developmental ability to design complex experiments. These students are able to make classifications based on definitions such as physical properties and characteristics. Students at this level demonstrate a rudimentary understanding of basic models and can identify some parts of physical and biological systems. They are also able to identify some patterns in nature and rates of change over time. These students have the ability to identify basic scientific facts and terminology and have a rudimentary understanding of the scientific principles underlying such phenomena as volcanic activity, disease transmission, and energy transformation. In addition, they have familiarity with the application of technology.
PROFICIENT 178	Students performing at the *Proficient* level demonstrate the knowledge and reasoning abilities required for understanding of the earth, physical, and life sciences at a level appropriate to Grade 12. In addition, they demonstrate knowledge of the themes of science (models, systems, patterns of change) required for understanding how these themes illustrate essential relationships among the earth, physical, and life sciences. They are able to analyze data and apply scientific principles to everyday situations. Twelfth-grade students performing at the *Proficient* level are able to demonstrate a working ability to design and conduct scientific investigations. They are able to analyze data in various forms and utilize information to provide explanations and to draw reasonable conclusions. Students at this level have a developmental understanding of both physical and conceptual models and are able to compare various models. They recognize some inputs and outputs, causes and effects, and interactions of a system. In addition, they can correlate structure to function for the parts of a system that they can identify. These students also recognize that rate of change depends on initial conditions and other factors. They are able to apply scientific concepts and principles to practical applications and solutions for problems in the real world and show a developmental understanding of technology, its uses, and its applications.

* Shaded areas indicate summary of content descriptions.

Table A.4 continued

1996 NAEP Science Achievement Level Descriptions: Grade 12

Cut Score	Content Descriptions*
ADVANCED **210**	Students performing at the *Advanced* level demonstrate the knowledge and reasoning abilities required for a solid understanding of the earth, physical, and life sciences at a level appropriate to Grade 12. In addition, they demonstrate knowledge of the themes of science (models, systems, pattern of change) required for integrating knowledge and understanding of scientific principles from the earth, physical, and life sciences. Students can design investigations that answer questions about real-world situations and use their reasoning abilities to make predications. Twelfth-grade students performing at the *Advanced* level are able to design scientific investigations to solve complex, real-world situations. They can integrate, interpolate, and extrapolate information embedded in data to draw well-formulated explanations and conclusions. They are also able to use complex reasoning skills to apply scientific knowledge to make predictions based on conditions, variables, and interactions. Students at this level recognize the inherent strengths and limitations of models and can revise models based on additional information. They are able to recognize cause-and-effect relationships within systems and can utilize this knowledge to make reasonable predictions of future events. These students are able to recognize that patterns can be constant, exponential, or irregular and can apply this recognition to make predictions. They can also design a technological solution for a given problem.

* Shaded areas indicate summary of content descriptions.

Estimating Variability

Because the statistics presented in this report are estimates of group and subgroup performance based on samples of students rather than the values that could be calculated if every student in the nation had answered every question, the degree of uncertainty associated with the estimates should be taken into account. Two components of uncertainty are accounted for in the variability of statistics based on student ability: (1) the uncertainty due to sampling only a relatively small number of students and (2) the uncertainty due to sampling only a relatively small number of cognitive questions. The first component accounts for the variability associated with the estimated percentages of students who had certain background characteristics or who answered a certain cognitive question correctly.

Because NAEP uses complex sampling procedures, conventional formulas for estimating sampling variability that assume simple random sampling are inappropriate. NAEP uses a jackknife replication procedure to estimate standard errors. The jackknife standard error provides a reasonable measure of uncertainty for any student information that can be observed without error. However, because each student typically responds to only a few questions within any content area, the scale score for any single student would be imprecise. In this case, plausible values technology can be used to describe the performance of groups and subgroups of students, but the underlying imprecision involved in this step adds another component of variability to statistics based on NAEP scale scores.[9] Appendix B provides the standard errors for the results presented in this report.

When the standard error is based on a small number of students or when the group of students is enrolled in a small number of schools, the amount of uncertainty associated with the standard error may be quite large.

The reader is reminded that, like findings from all surveys, NAEP results are subject to other kinds of error, including the effects of imperfect adjustment for student and school nonresponse and unknowable effects associated with the particular instrumentation and data collection methods. Nonsampling errors can be attributed to a number of sources; inability to obtain complete information about all selected schools in the sample (some students or schools refused to participate, or students participated but answered only certain questions); ambiguous definitions; differences in interpreting questions; inability or unwillingness to give correct information; mistakes in recording, coding, or scoring data; and other errors in data collecting, data processing, and sampling, and in estimating missing data. The extent of nonsampling error is difficult to estimate, and because of their nature, the impact of such errors cannot be reflected in the data-based estimates of uncertainty provided in NAEP reports.

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[9] For further details, see Johnson, E. G., & Rust, K. F. (1992). Population inferences and variance estimation for NAEP data. *Journal of Educational Statistics, 17*, 175-190.

Drawing Inferences from the Results

The results from the sample, taking into account the uncertainty associated with all samples, are used to make inferences about the population. Using confidence intervals based on the standard errors provides a way to make inferences about the population averages and percentages in a manner that reflects the uncertainty associated with the sample estimates. An estimated sample average scale score ± 2 standard errors approximates a 95 percent confidence interval for the corresponding population quantity. This statement means that one can conclude at the 95 percent confidence level that the average performance of the entire population of interest (e.g., all fourth-grade students in public schools in a jurisdiction) is within ± 2 standard errors of the sample average.

As an example, suppose that the average science scale score of the students in a particular group was 156 with a standard error of 1.2. A 95 percent confidence interval for the population quantity would be as follows:

Average ± 2 standard errors
$156 \pm 2 \times 1.2$
156 ± 2.4
153.6, 158.4

Thus, one can conclude at the 95 percent level of confidence that the average scale score for the entire population of students in that group is between 153.6 and 158.4.

Similar confidence intervals can be constructed for percentages, if the percentages are not extremely large or extremely small. For extreme percentages, confidence intervals constructed in the manner above may not be appropriate, and accurate confidence intervals can be constructed only by using procedures that are quite complicated.

Extreme percentages, defined by both the magnitude of the percentage and the size of the sample from which it was derived, should be interpreted with caution. (The forthcoming *NAEP 1996 Technical Report* contains a more complete discussion of extreme percentages.)[10]

Statistical Tests for Determining Group Differences in Performance

Statistical tests are used to determine whether the evidence, based on the data from the groups in the sample, is strong enough to indicate that the averages or percentages are actually different for those groups in the population. If the evidence is strong (i.e., the difference is statistically significant), the report describes the group averages or percentages as being different (e.g., one group performed higher or lower than another group), regardless of whether the sample averages or percentages appear to be approximately the same. If the evidence is not sufficiently strong (i.e., the difference is not statistically significant), the averages or percentages are described as being not significantly different, regardless of whether the sample averages or percentages appear to be approximately the same or widely discrepant.

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[10] Allen, N.L., Carlson, J., & Zelenak, C. A. (1998). *NAEP 1996 technical report* (Publication No. NCES 98-479). Washington, DC: National Center for Education Statistics. Report in preparation.

The reader is cautioned to rely on the results of the statistical tests rather than on the apparent magnitude of the difference between sample averages or percentages when determining whether the sample differences are likely to represent actual differences among the groups in the population.

To determine whether a real difference exists between the average scale scores (or percentages of a certain attribute) for two independently sampled groups in the population, one needs to obtain an estimate of the degree of uncertainty associated with the difference between the averages (or percentages) of these groups for the sample. This estimate of the degree of uncertainty, called the standard error of the difference between the groups, is obtained by taking the square of each group's standard error, summing the squared standard errors, and taking the square root of that sum.

Standard Error of the Difference for Independent Groups = $SE_{A-B} = \sqrt{(SE_A^2 + SE_B^2)}$

In a manner similar to that in which the standard error for an individual group average or percentage is used, the standard error of the difference can be used to help determine whether differences among groups in the population are real. The difference between the averages or percentages of the two groups plus or minus two standard errors of the difference represents an approximate 95 percent confidence interval. If the resulting interval includes zero, there is insufficient evidence to claim a real difference between the groups in the population. If the interval does not contain zero, the difference between the groups is statistically significant (different) at the .05 level. In this report, differences among groups that involve poorly defined variability estimates and extreme percentages are not discussed.

As an example, to determine whether the average science scale score of Group A is higher than that of Group B, suppose that the sample estimates of the average scale scores and standard errors were as follows:

Group	Average Scale Score	Standard Error
A	118	0.9
B	116	1.1

The difference between the estimates of the average scale scores of Groups A and B is two points (118 - 116). The standard error of this difference is

$$\sqrt{0.9^2 + 1.1^2} = 1.4$$

Thus, an approximate 95 percent confidence interval for this difference is

$$\text{Difference} \pm 2 \text{ standard errors of the difference}$$

$$2 \pm 2 \times 1.4$$

$$2 \pm 2.8$$

$$-0.8, 4.8$$

The value zero is within the confidence interval; therefore, there is insufficient evidence to claim that Group A outperformed Group B.

The procedures described in this section and the certainty ascribed to intervals (e.g., a 95 percent confidence interval) are based on statistical theory that assumes that only one confidence interval or test of statistical significance is being performed. However, in Chapters 2 to 5 of this report, many different groups are being compared (i.e., multiple sets of confidence intervals are being analyzed). In sets of confidence intervals, statistical theory indicates that the certainty associated with the entire set of intervals is less than that attributable to each individual comparison from the set. To hold the significance level for the set of comparisons at a particular level (e.g., 0.05), adjustments called multiple comparison procedures must be made to the methods described in the previous section. One such procedure, the Bonferroni method, was used in the analyses described in this report to adjust the confidence intervals for the differences among groups when sets of comparisons were considered.[11] Many of the confidence intervals discussed in the main body of this report were components of a set of multiple comparisons, and so included Bonferroni adjustments. Thus the confidence intervals for these comparisons are more conservative than the confidence interval (described above) for what a single comparison would be.

Most of the multiple comparisons in this report pertain to relatively small sets or families of comparisons. For example, for discussions concerning comparisons of student performance with a particular science course taken, six comparisons were conducted, that is, all pairs of the four science courses were compared. In these situations, Bonferroni procedures were appropriate. However, for the cross-state comparisons with a large family of comparisons, the False Discovery Rate (FDR) procedure was used to control the certainty level.[12]

Unlike the Bonferroni procedure, which controls the familywise error rate (i.e., the probability of making even one false rejection in the set of comparisons), the FDR procedure controls the expected proportion of falsely rejected hypotheses. Furthermore, Bonferroni procedures are considered conservative for large families of comparisons.[13] Therefore, the FDR procedure is more suitable for cross-state comparisons. A detailed description of the Bonferroni and FDR procedures appears in the *Technical Report: NAEP 1996 State Assessment Program in Science* and the *NAEP 1996 Technical Report*.[14]

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[11] Miller, R. G. (1966). *Simultaneous statistical inference*. New York, NY: McGraw-Hill.

[12] Benjamini, Y., & Hochberg, Y. (1994). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society, Series B, 57*(1), 289-300.

[13] Williams, V. S. L., Jones, L. V., & Tukey, J. W. (1994, December). *Controlling error in multiple comparisons with special attention to the National Assessment of Educational Progress*. Research Triangle Park, NC: National Institute of Statistical Sciences.

[14] Allen, N. L., Swinton, S. S., Isham, S. P., & Zelenak, C. A. (1997). *Technical report of the NAEP 1996 state assessment program in science* (Publication No. NCES 98-480). Washington, DC: National Center for Education Statistics.

Allen, N. L., Carlson, J. E., & Zelenak, C. A. (1998). *The NAEP 1996 technical report* (Publication No. NCES 98-479). Washington, DC: National Center for Education Statistics. Report in preparation.

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Jurisdiction Rankings

Some of the results for jurisdictions that participated in the assessment are reported in three categories: jurisdictions where the percentage is above the national average; jurisdictions where the percentage does not differ significantly from the national average; and jurisdictions where the percentage is below the national average. Each jurisdiction was classified into one of the categories based on whether its results were statistically significant from the national average.

Derived Variables

Several of the tables in this report contain data from derived variables. A derived variable is a variable that is created by combining responses from two or more variables into one set of responses. The following variables and their corresponding tables contain data from variables that were derived.

Table 2.2, Table 2.3, and Figure 2.1, along with the corresponding standard error tables in Appendix B, contain data involving teachers' major field of study. For grades 4 and 8, teachers' major field of study was derived by combining 27 questions from the teacher questionnaire. First, it was determined if a teacher had a science major, which was true if their undergraduate or graduate major was life, physical, or earth science. If they did not have a science major, it was then determined if their major was science education. Then, it was determined if a teacher's major was education, which was true if their major was education, elementary education or secondary education. Of the remaining teachers, it was determined if they had a major field of study other than science, science education, or education. If a teacher did not indicate any major field of study, they were categorized as 'none.'

Table 2.2 and Table B2.2 contain data for teachers' major or minor field of study. For grades 4 and 8 teachers' major or minor field of study was derived by combining 42 questions from the teacher questionnaire. It was derived the same as major field of study except that teacher's minors were included. For example, if a teacher had a science major or minor in their undergraduate or graduate studies, they were categorized as "science." Again, the order in which a teacher's major/minor was determined was science, science education, education, other, and none.

Tables 2.6, 2.7, B2.6, and B2.7 contain information regarding teachers' area of certification. A fourth- or eighth-grade teacher was determined to have a science teaching certificate if they were certified in elementary or secondary science. They could be certified in other areas as well. A teacher was determined to have an education certificate if they were certified in elementary or secondary education and not certified in science. However, they could be certified in subjects other than science. A teacher was determined to be certified in an 'other' subject if they were certified in a subject other than science or education and did not have a certificate in science.

Figures 2.3, 2.4, 2.5, and 2.6, along with their corresponding standard error tables in Appendix B, contain information on whether or not a teacher has taken a course or participated in professional development activities in technology and/or telecommunications, portfolios and/or performance-based assessment, or teaching students from different cultural backgrounds and/or students who had limited English skills. If a fourth- or eighth-grade teacher indicated that they had taken a course or participated in professional development activities in telecommunications or technology, they were included in the "technology and/or telecommunications" variable. If they had taken a course or participated in professional development activities involving portfolio-based or performance-based assessment, they were included in the "portfolio-based and/or performance-based assessment" variable. If they had taken a course or participated in professional development activities that involved teaching students from different cultural backgrounds or students with limited English skills, they were included in the "teaching students who have multicultural backgrounds and/or limited English skills" variable.

Tables 4.4a, 4.4b, and 4.5, along with their corresponding standard error tables in Appendix B, contain information about the type of coursework that twelfth graders have taken since ninth grade. Subject areas and combinations of subject areas include: Earth and Space Science, Life Science, Biology, Physical Science, Chemistry, Physics, General Science, Integrated Science, Science and Technology, Other Science, Earth Science and Biology, Earth Science and Chemistry, Earth Science and Physics, Biology and Chemistry, Biology and Physics, Chemistry and Physics, Earth Science and Biology and Chemistry, Earth Science and Biology and Physics, Earth Science and Chemistry and Physics, Biology and Chemistry and Physics, and Earth Science and Biology and Chemistry and Physics. A grade 12 student was determined to have taken a science subject if they had any course work in that subject since the 9th grade (more than one year, one year, or less than one year were combined). A student who had taken more than one subject could be included in more than one of the derived variables.

Appendix B

Standard Errors

The comparisons presented in this report are based on statistical tests that consider the magnitude of the difference between group averages or percentages and the standard errors of those statistics. The following appendix contains the standard errors for the averages and percentages discussed in Chapters 2, 3, 4, and 5.

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TABLE B2.2 Teachers' Reports on Their Undergraduate or Graduate Fields of Study: Public and Nonpublic Schools Combined 111

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TABLE B2.5 Teachers' Reports on Type of Teaching Certificate Held in Main Assignment Field, for the Nation and Jurisdictions: Public Schools Only 114

TABLE B2.6 Teachers' Reports on the Subject Area Covered by Teaching Certificate, by Public Schools Only 115

TABLE B2.7 Teachers' Reports on the Subject Area Covered by Teaching Certificate, for the Nation and Jurisdictions: Public Schools Only 116

FIGURE B2.2 Teachers' Reports on Number of Years Teaching Science: Public and Nonpublic Schools Combined 117

TABLE B2.8 Teachers' Reports on Amount of Time Spent in Professional Development Workshops or Seminars in Science or Science Education During the Last Year: Public and Nonpublic Schools Combined 118

FIGURE B2.3 Teachers' Reports on Professional Development Activities Over the Last Five Years: Public and Nonpublic Schools Combined 119

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TABLE B3.1 Schools' Reports on Whether They Have a Science Curriculum: Public Schools Only 121

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TABLE B3.3 Schools' Reports on How Often a Typical Student Receives Instruction in Science, for the Nation and Jurisdictions: Public Schools Only 123

TABLE B3.4 Schools' Reports on Years of Science Required for Graduation: Public and Nonpublic Schools Combined 124

TABLE B3.5 Students' Reports on Semester Hours of Science Taken from Grades 9 - 12: Public and Nonpublic Schools Combined 124

TABLE B3.6 Schools' Reports on Types of Advanced Level Courses Taught: Public and Nonpublic Schools Combined 125

TABLE B3.7 Schools' Reports on Requirements to Pass a District or State Test in Science in Order to Graduate: Public and Nonpublic Schools Combined 125

TABLE B4.1 Teachers' Reports on How Much Time is Spent Teaching Certain Science Domains: Public and Nonpublic Schools Combined 126

TABLE B4.2 Teachers' Reports on How Much Time is Spent Teaching Certain Science Domains: Public and Nonpublic Schools Combined 127

TABLE B4.3 Students' Reports on Science Course-Taking: Public and Nonpublic Schools Combined 127

TABLE B4.4a Students' Reports on Science Courses Taken from Grades 9-12, by Gender: Public and Nonpublic Schools Combined 128

TABLE B4.4b Students' Reports on Science Courses Taken from Grades 9-12, by Gender: Public and Nonpublic Schools Combined 129

TABLE B4.5 Students' Reports on Combinations of Science Courses Taken from Grades 9-12, by Gender: Public and Nonpublic Schools Combined 130

TABLE B4.6 Students' Reports on Current Science Course-Taking: Public and Nonpublic Schools Combined 131

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TABLE B5.1 Teachers' Reports on Whether They Receive the Resources They Need: Public and Nonpublic Schools Combined 132

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FIGURE B5.2 Teachers' Reports on Availability of Computers for Use by Their Science Students: Public and Nonpublic Schools Combined 134

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FIGURE B5.4 Teachers' Reports on Availability of a Curriculum Specialist in Science: Public and Nonpublic Schools Combined 136

FIGURE B5.5 Teachers' Reports on Availability of a Curriculum Specialist in Science, for the Nation and Jurisdictions: Public Schools Only 137

FIGURE B5,6 Teachers' Reports on What Space is Available for Teaching Science: Public and Nonpublic Schools Combined 138

TABLE B2.1

Standard Errors for Teachers' Reports on Their Highest Degree, by Type of School

What is the highest academic degree you hold?	Grade 4			Grade 8		
	Public and Nonpublic Schools	Public Schools Only	Nonpublic Schools Only	Public and Nonpublic Schools	Public Schools Only	Nonpublic Schools Only
	Percentage, Average Scale Score, and Achievement Level of Students					
High School, Associates Degree, or Vocational Certification						
Percentage of Students	0.5	***	4.2	***	***	***
Average Scale Score	***	***	***	***	***	***
Percentage At or Above *Proficient*	***	***	***	***	***	***
Bachelor's						
Percentage of Students	2.7	3.0	6.1	3.8	4.2	6.9
Average Scale Score	1.3	1.4	2.4	1.3	1.3	3.1
Percentage At or Above *Proficient*	1.6	1.8	3.3	1.7	1.8	4.4
Master's or Specialist's						
Percentage of Students	2.7	3.0	5.2	3.9	4.2	6.8
Average Scale Score	1.5	1.6	3.1	1.6	1.7	4.2
Percentage At or Above *Proficient*	1.8	2.0	5.3	2.4	2.5	6.6
Doctorate or Professional						
Percentage of Students	***	***	***	0.4	0.5	***
Average Scale Score	***	***	***	10.8	7.7	***
Percentage At or Above *Proficient*	***	***	***	11.0	6.1	***

***Standard error cannot be accurately determined.

NOTE: Numbers may not add up to 100 due to rounding.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B2.2

Standard Errors for Teachers' Reports on Their Undergraduate or Graduate Fields of Study: Public and Nonpublic Schools Combined

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What were your fields of study?	Grade 4		Grade 8	
	Major	**Major or Minor**	**Major**	**Major or Minor**
Science				
Percentage of Students	1.2	1.4	3.7	3.6
Average Scale Score	8.1	5.7	1.4	1.3
Percentage At or Above *Proficient*	7.2	5.3	1.7	1.8
Science Education but not Science				
Percentage of Students	0.9	1.0	2.1	1.8
Average Scale Score	3.8	3.1	2.5	2.6
Percentage At or Above *Proficient*	4.3	4.0	3.2	3.0
Education but not Science or Science Education				
Percentage of Students	2.5	2.4	2.5	2.8
Average Scale Score	1.1	1.2	2.8	2.9
Percentage At or Above *Proficient*	1.3	1.5	3.1	3.2
Other				
Percentage of Students	1.8	1.9	2.4	0.8
Average Scale Score	3.4	3.5	3.6	8.2
Percentage At or Above *Proficient*	3.1	3.6	4.2	9.0
Missing/None Indicated				
Percentage of Students	1.7	1.7	2.3	2.3
Average Scale Score	3.1	3.1	2.9	2.9
Percentage At or Above *Proficient*	2.5	2.5	3.1	3.1

NOTE: Numbers may not add up to 100 due to rounding.

This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.The missing/none category includes missing data at the undergraduate and graduate levels; teachers who had no graduate level study and who failed to indicate an undergraduate major; and teacher questionnaires not matched to students.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B2.3 and FIGURE B2.1

Standard Errors for Teachers' Reports on Their Undergraduate or Graduate Fields of Study, for the Nation and Jurisdictions: Public Schools Only

What were your fields of study?	Science	Science Education but not Science	Education but not Science or Science Ed.	Other	Missing/ None Indicated	Total % At or Above *Proficient*
Grade 8	Percentage of Students					
Nation	4.1	2.3	2.6	2.7	2.5	1.3
Alabama	4.6	3.2	2.6	1.3	2.3	1.5
Alaska°	2.1	0.6	1.2	1.0	1.8	1.6
Arizona	4.6	3.1	4.4	1.3	2.1	1.7
Arkansas°	4.3	3.5	4.2	1.8	1.8	1.5
California	3.6	1.6	3.1	1.2	2.6	1.7
Colorado	3.5	1.6	1.9	1.2	2.7	1.2
Connecticut	3.9	2.7	2.4	0.9	2.5	1.7
Delaware	0.9	0.5	0.6	0.4	0.5	1.0
DDESS	1.2	1.0	1.1	***	0.6	2.2
DoDDS	0.6	0.2	0.7	0.5	0.5	1.3
District of Columbia	1.0	1.2	0.6	0.4	0.9	0.9
Florida	3.4	2.5	2.4	1.6	3.6	1.6
Georgia	2.5	2.0	2.7	1.5	2.5	1.7
Guam	0.8	0.9	0.6	***	0.9	1.0
Hawaii	0.6	0.2	0.5	0.4	0.8	1.0
Indiana	4.5	3.5	2.9	1.5	3.1	1.9
Iowa°	5.1	2.7	4.6	0.1	2.3	1.6
Kentucky	3.8	3.1	3.9	0.5	3.8	1.3
Louisiana	3.5	2.9	3.2	1.8	2.8	1.2
Maine	3.0	3.1	3.3	0.9	1.8	1.8
Maryland°	3.8	2.2	1.9	2.3	2.5	1.8
Massachusetts	3.2	2.5	2.7	1.1	2.8	1.7
Michigan°	4.5	3.6	3.0	1.0	3.7	2.0
Minnesota	4.2	3.1	2.0	***	2.2	1.7
Mississippi	3.2	2.6	3.5	1.8	2.6	1.0
Missouri	4.1	2.5	2.9	1.0	3.2	1.3
Montana°	2.7	1.2	3.4	1.5	2.3	2.1
Nebraska	3.1	2.5	1.8	0.1	2.6	1.5
New Mexico	2.5	1.4	1.8	1.3	2.0	0.7
New York°	3.5	1.2	1.3	1.6	3.5	1.7
North Carolina	3.1	2.9	2.6	1.1	2.8	1.4
North Dakota	2.8	2.4	1.9	1.9	1.1	1.5
Oregon	3.9	3.0	2.6	0.9	2.5	1.8
Rhode Island	1.0	0.8	0.7	0.5	0.5	1.5
South Carolina°	4.3	2.7	3.0	2.3	2.4	1.4
Tennessee	4.3	3.1	4.7	1.6	2.4	1.7
Texas	3.7	2.7	1.7	2.2	2.8	1.5
Utah	2.2	0.6	1.3	1.2	1.4	1.2
Vermont°	3.0	2.7	1.6	1.1	2.5	1.6
Virginia	3.1	2.4	2.3	2.2	1.2	2.1
Washington	3.9	1.4	3.0	1.6	3.8	1.6
West Virginia	4.1	3.3	2.3	0.8	2.1	1.1
Wisconsin°	4.6	1.4	4.5	***	3.7	1.9
Wyoming	0.8	0.3	0.6	0.3	0.5	1.3

***Standard error cannot be accurately determined.

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B2.4

Standard Errors for Teachers' Reports on Type of Teaching Certificate Held in Main Assignment Field: Public Schools Only

THE NATION'S REPORT CARD naep

What type of teaching certificate do you have in this state in your main assignment field?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
Certified		
Percentage of Students	1.3	1.7
Average Scale Score	1.0	1.2
Percentage At or Above *Proficient*	1.2	1.6
Temporary, Provisional, or Emergency Certification		
Percentage of Students	1.3	1.7
Average Scale Score	6.9	3.2
Percentage At or Above *Proficient*	6.3	4.6
None		
Percentage of Students	***	0.5
Average Scale Score	***	***
Percentage At or Above *Proficient*	***	***

***Standard error cannot be accurately determined.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B2.5

Standard Errors for Teachers' Reports on Type of Teaching Certificate Held in Main Assignment Field, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

What type of teaching certificate do you have in this state in your main assignment field?	Certified	Temporary, Provisional or Emergency Certification	None	Total % At or Above *Proficient*
Grade 8	**Percentage of Students**			
Nation	1.7	1.7	0.5	1.3
Alabama	0.8	***	0.6	1.5
Alaska°	0.4	1.0	***	1.6
Arizona	3.3	2.6	2.1	1.7
Arkansas°	1.4	0.8	1.1	1.5
California	3.2	2.6	1.6	1.7
Colorado	2.8	2.6	1.0	1.2
Connecticut	2.7	2.3	1.5	1.7
Delaware	0.8	0.7	0.4	1.0
DDESS	1.1	0.8	0.8	2.2
DoDDS	0.8	***	0.1	1.3
District of Columbia	1.5	1.5	***	0.9
Florida	2.5	2.5	0.5	1.6
Georgia	1.0	1.0	***	1.7
Guam	***	***	***	1.0
Hawaii	1.0	0.8	0.7	1.0
Indiana	1.7	1.6	***	1.9
Iowa°	1.7	1.7	***	1.6
Kentucky	2.6	2.6	***	1.3
Louisiana	3.3	3.1	1.1	1.2
Maine	2.8	2.8	***	1.8
Maryland°	2.8	2.7	***	1.8
Massachusetts	1.5	0.8	1.3	1.7
Michigan°	3.7	3.2	1.3	2.0
Minnesota	1.5	1.5	***	1.7
Mississippi	2.6	2.5	0.8	1.0
Missouri	2.8	2.8	***	1.3
Montana°	1.8	1.8	***	2.1
Nebraska	1.5	1.5	0.0	1.5
New Mexico	0.9	0.9	0.1	0.7
New York°	2.5	2.4	0.7	1.7
North Carolina	2.5	2.3	0.7	1.4
North Dakota	0.6	0.3	***	1.5
Oregon	2.0	2.0	1.3	1.8
Rhode Island	0.8	0.8	***	1.5
South Carolina°	2.2	2.1	1.0	1.4
Tennessee	2.1	2.1	***	1.7
Texas	2.6	2.4	0.5	1.5
Utah	2.3	2.3	0.1	1.2
Vermont°	0.7	0.7	***	1.6
Virginia	1.7	1.6	0.5	2.1
Washington	1.8	1.8	***	1.6
West Virginia	1.3	1.3	0.4	1.1
Wisconsin°	***	***	***	1.9
Wyoming	0.1	0.1	***	1.3

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

***Standard error cannot be accurately determined.

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

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TABLE B2.6 Standard Errors for Teachers' Reports on the Subject Area Covered by Teaching Certificate, Public Schools Only

THE NATION'S REPORT CARD naep

Do you have a teaching certificate in any of the following areas that is recognized by the state in which you teach?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students Whose Teachers Responded Yes	
Science		
Percentage of Students	2.9	3.1
Average Scale Score	2.3	1.1
Percentage At or Above *Proficient*	2.5	1.5
Education, but not Science		
Percentage of Students	3.0	1.9
Average Scale Score	1.2	5.2
Percentage At or Above *Proficient*	1.6	5.4
Other		
Percentage of Students	0.4	0.4
Average Scale Score	—	7.2
Percentage At or Above *Proficient*	—	4.8

NOTE: This table contains information obtained from three derived variables. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B2.7

Standard Errors for Teachers' Reports on the Subject Area Covered by Teaching Certificate, for the Nation and Jurisdictions: Public Schools Only

Do you have a teaching certificate in any of the following areas that is recognized by the state in which you teach?	Area of Certification			
	Science	Education, But Not Science	Other	Total % At or Above *Proficient*
Grade 8	Percentage of Students Whose Teachers Responded Yes			
Nation	3.1	1.9	0.4	1.3
Alabama	3.9	2.6	***	1.5
Alaska[a]	2.6	1.8	0.4	1.6
Arizona	4.2	4.0	0.7	1.7
Arkansas[a]	2.5	1.6	***	1.5
California	2.9	2.2	0.8	1.7
Colorado	3.2	1.9	1.1	1.2
Connecticut	3.4	3.1	***	1.7
Delaware	0.9	0.8	0.3	1.0
DDESS	1.2	1.1	***	2.2
DoDDS	0.5	***	0.1	1.3
District of Columbia	1.0	0.8	0.1	0.9
Florida	3.3	1.2	1.3	1.6
Georgia	3.2	3.2	0.7	1.7
Guam	1.0	0.9	***	1.0
Hawaii	0.8	0.3	0.2	1.0
Indiana	3.9	2.4	0.1	1.9
Iowa[a]	2.9	2.1	1.0	1.6
Kentucky	4.0	3.6	1.0	1.3
Louisiana	4.3	3.9	1.9	1.2
Maine	3.1	3.1	***	1.8
Maryland[a]	2.8	2.1	1.1	1.8
Massachusetts	2.6	2.2	1.0	1.7
Michigan[a]	4.1	3.0	0.7	2.0
Minnesota	2.6	***	***	1.7
Mississippi	4.1	3.9	0.8	1.0
Missouri	3.7	2.0	***	1.3
Montana[a]	3.6	3.9	***	2.1
Nebraska	2.8	1.9	0.0	1.5
New Mexico	2.4	1.8	0.6	0.7
New York[a]	3.5	1.5	0.4	1.7
North Carolina	3.1	2.0	0.8	1.4
North Dakota	1.8	1.5	***	1.5
Oregon	3.2	2.5	0.7	1.8
Rhode Island	0.6	0.3	0.1	1.5
South Carolina[a]	3.6	2.7	1.5	1.4
Tennessee	4.3	3.8	0.3	1.7
Texas	3.5	0.9	0.6	1.5
Utah	1.8	1.1	0.2	1.2
Vermont[a]	2.7	0.6	***	1.6
Virginia	2.6	2.1	0.7	2.1
Washington	4.4	3.0	***	1.6
West Virginia	2.7	1.9	***	1.1
Wisconsin[a]	4.4	3.5	***	1.9
Wyoming	0.7	0.5	0.1	1.3

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

***Standard error cannot be accurately determined.

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE B2.2

Standard Errors for Teachers' Reports on Number of Years Teaching Science: Public and Nonpublic Schools Combined

Counting this year, how many years in total have you taught science?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
2 Years or Less		
Percentage of Students	1.4	2.2
Average Scale Score	2.5	2.6
Percentage At or Above *Proficient*	2.2	2.7
3 - 5 Years		
Percentage of Students	1.6	2.1
Average Scale Score	2.3	2.9
Percentage At or Above *Proficient*	3.6	3.6
6 - 10 Years		
Percentage of Students	1.9	2.8
Average Scale Score	2.6	1.7
Percentage At or Above *Proficient*	3.4	2.1
11 - 24 Years		
Percentage of Students	2.1	3.1
Average Scale Score	2.0	2.7
Percentage At or Above *Proficient*	2.5	3.8
25 + Years		
Percentage of Students	2.1	2.7
Average Scale Score	2.6	2.8
Percentage At or Above *Proficient*	3.3	4.1

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B2.8 Standard Errors for Teachers' Reports on Amount of Time Spent in Professional Development Workshops or Seminars in Science or Science Education During the Last Year: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

During the last year, how much time in total have you spent in professional development workshops or seminars in science or science education?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
None		
Percentage of Students	2.7	2.2
Average Scale Score	1.7	3.5
Percentage At or Above *Proficient*	2.5	4.0
Less than 6 Hours		
Percentage of Students	2.4	3.8
Average Scale Score	1.5	3.7
Percentage At or Above *Proficient*	2.0	4.7
6 - 15 Hours		
Percentage of Students	2.7	2.5
Average Scale Score	2.8	3.7
Percentage At or Above *Proficient*	3.2	4.3
16 - 35 Hours		
Percentage of Students	1.4	3.6
Average Scale Score	4.4	2.4
Percentage At or Above *Proficient*	4.8	3.7
More than 35 Hours		
Percentage of Students	1.9	3.1
Average Scale Score	5.6	1.6
Percentage At or Above *Proficient*	4.5	2.6

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE B2.3

Standard Errors for Teachers' Reports on Professional Development Activities Over the Last Five Years: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

During the past five years, have you taken courses or participated in professional development activities in any of the following?	Use of Technology and/or Telecommunications	Portfolio-Based and/or Performance-Based Assessments	Teaching Students who have Multicultural Backgrounds and/or Limited English Skills
	Percentage, Average Scale Score, and Achievement Level of Students Whose Teachers Responded Yes		
Grade 4			
Percentage of Students	2.3	2.9	2.7
Average Scale Score	1.0	1.1	1.5
Percentage At or Above *Proficient*	1.3	1.3	1.7
Grade 8			
Percentage of Students	2.9	4.1	3.0
Average Scale Score	0.9	1.7	1.4
Percentage At or Above *Proficient*	1.4	2.4	1.4

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURES B2.4, B2.5, and B2.6

Standard Errors for Teachers' Reports on Professional Development Activities Over the Last Five Years, for the Nation and Jurisdictions: Public Schools Only

During the past five years, have you taken courses or participated in professional development activities in any of the following?	Use of Technology and/or Telecommunications	Portfolio-Based and/or Performance-Based Assessments	Teaching Students who have Multicultural Backgrounds and/or Limited English Skills	Total % At or Above *Proficient*
Grade 8	Percentage of Students Whose Teachers Responded Yes			
Nation	3.2	4.7	3.3	1.3
Alabama	3.3	3.7	2.8	1.5
Alaska°	2.1	2.1	2.8	1.6
Arizona	4.2	4.6	4.0	1.7
Arkansas°	4.9	4.8	3.7	1.5
California	3.1	3.8	3.4	1.7
Colorado	3.2	4.0	4.0	1.2
Connecticut	3.1	3.5	3.4	1.7
Delaware	0.9	1.1	0.9	1.0
DDESS	0.9	1.5	1.2	2.2
DoDDS	0.8	1.0	1.1	1.3
District of Columbia	0.9	0.9	0.8	0.9
Florida	3.2	4.0	3.7	1.6
Georgia	3.1	3.6	2.7	1.7
Guam	0.9	1.0	1.2	1.0
Hawaii	0.8	0.5	0.5	1.0
Indiana	4.2	4.2	2.9	1.9
Iowa°	3.8	4.7	3.6	1.6
Kentucky	4.1	3.9	3.3	1.3
Louisiana	4.3	4.1	3.5	1.2
Maine	3.4	3.3	1.7	1.8
Maryland°	3.4	4.3	4.0	1.8
Massachusetts	3.4	3.8	3.6	1.7
Michigan°	4.0	4.4	4.0	2.0
Minnesota	3.9	3.4	3.9	1.7
Mississippi	3.4	3.6	2.8	1.0
Missouri	4.0	4.3	3.6	1.3
Montana°	3.3	4.0	3.3	2.1
Nebraska	3.0	3.1	3.9	1.5
New Mexico	2.0	2.3	2.5	0.7
New York°	4.1	3.8	3.1	1.7
North Carolina	3.5	3.6	3.9	1.4
North Dakota	2.1	2.2	1.8	1.5
Oregon	3.7	3.3	3.5	1.8
Rhode Island	0.9	0.9	0.6	1.5
South Carolina°	4.1	3.9	2.9	1.4
Tennessee	3.3	4.5	3.6	1.7
Texas	3.7	3.8	3.7	1.5
Utah	2.3	2.3	2.7	1.2
Vermont°	3.2	3.1	1.2	1.6
Virginia	2.6	3.4	3.5	2.1
Washington	3.6	4.6	3.6	1.6
West Virginia	2.5	4.1	2.3	1.1
Wisconsin°	4.0	4.3	3.0	1.9
Wyoming	0.6	0.8	0.4	1.3

° Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.1

Standard Errors for Schools' Reports on Whether They Have a Science Curriculum: Public Schools Only

THE NATION'S REPORT CARD naep

Does your district or state have a curriculum in science that your school is expected to follow?	Grade 4	Grade 8	Grade 12
	Percentage, Average Scale Score, and Achievement Level of Students		
Yes			
Percentage of Students	2.3	2.0	3.1
Average Scale Score	0.9	1.0	1.2
Percentage At or Above *Proficient*	1.1	1.4	1.5
No			
Percentage of Students	2.3	2.0	3.1
Average Scale Score	6.0	5.7	2.3
Percentage At or Above *Proficient*	3.5	7.1	2.6

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.2 Standard Errors for Schools' Reports on How Often a Typical Student Receives Instruction in Science: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

How often does a typical fourth-grade student in your school receive instruction in science?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 4			
Every Day	3.8	2.0	2.1
3 - 4 Times a Week	4.0	2.2	2.2
1 - 2 Times a Week	3.0	3.0	3.2
Less Than Once a Week	***	***	***
Not Taught	***	***	***
How often does a typical eighth-grade student in your school receive instruction in science?			
Grade 8	2.4	1.1	1.4
3 - 4 Times a Week	2.5	4.1	5.1
1 - 2 Times a Week	0.4	***	***
Less Than Once a Week	***	***	***
Not Taught	***	***	***

***Standard error cannot be accurately determined.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.3

Standard Errors for Schools' Reports on How Often a Typical Student Receives Instruction in Science, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

How often does a typical eighth-grade student in your school receive instruction in science?	Every Day		3 - 4 Times per Week		Less than 3 Times per Week		Total % At or Above *Proficient*
Grade 8	Average % of Students	Scale Score	Average % of Students	Scale Score	Average % of Students	Scale Score	
Nation	2.7	1.2	2.7	4.8	***	***	1.3
Alabama	1.6	1.8	***	***	1.6	***	1.5
Alaska[a]	2.8	1.9	2.7	3.9	***	***	1.6
Arizona	2.6	1.9	2.3	***	1.2	***	1.7
Arkansas[a]	***	1.7	***	***	***	***	1.5
California	3.9	2.0	3.1	6.0	2.5	***	1.7
Colorado	1.2	1.1	1.2	***	***	***	1.2
Connecticut	***	1.4	***	***	***	***	1.7
Delaware	***	0.8	***	***	***	***	1.0
DDESS	***	1.3	***	***	***	***	2.2
DoDDS	0.4	0.8	0.4	***	***	***	1.3
District of Columbia	1.1	1.0	1.0	3.0	0.7	***	0.9
Florida	4.0	1.9	3.5	2.4	***	***	1.6
Georgia	***	1.6	***	***	***	***	1.7
Guam	***	1.3	***	***	***	***	1.0
Hawaii	0.5	1.4	0.5	1.6	0.4*	1.3	1.0
Indiana	***	1.5	***	***	***	***	1.9
Iowa[a]	1.7	1.2	1.7	***	***	***	1.6
Kentucky	2.2	1.5	2.1	***	***	***	1.3
Louisiana	***	1.6	***	***	***	***	1.2
Maine	3.0	1.0	3.0	3.3	***	***	1.8
Maryland[a]	2.3	1.7	2.3	***	***	***	1.8
Massachusetts	1.9	1.7	1.7	***	***	***	1.7
Michigan[a]	***	1.7	***	***	***	***	2.0
Minnesota	4.0	1.5	3.1	4.2	2.6	***	1.7
Mississippi	3.2	1.6	3.2	4.9	***	***	1.0
Missouri	3.9	1.4	4.0	4.5	***	***	1.3
Montana[a]	***	1.3	***	***	***	***	2.1
Nebraska	1.3	1.1	1.3	***	0.2	***	1.5
New Mexico	0.2	1.1	***	***	0.2	***	0.7
New York[a]	3.1	2.3	3.1	14.3	***	***	1.7
North Carolina	2.5	1.4	1.8	***	1.7	***	1.4
North Dakota	0.7	0.8	***	***	***	***	1.5
Oregon	3.9	2.0	3.9	2.8	***	***	1.8
Rhode Island	0.1	0.8	0.1	***	***	***	1.5
South Carolina[a]	2.2	1.6	2.2	***	***	***	1.4
Tennessee	2.3	2.0	***	***	2.3	***	1.7
Texas	4.5	1.6	4.3	6.6	***	***	1.5
Utah	1.1	1.0	1.1	***	0.1	***	1.2
Vermont[a]	2.4	1.0	2.4	1.7	***	***	1.6
Virginia	2.7	1.6	2.7	3.2	***	***	2.1
Washington	4.2	1.5	3.2	5.2	3.0	4.2	1.6
West Virginia	1.0	0.9	***	***	0.1	***	1.1
Wisconsin[a]	***	1.7	***	***	***	***	1.9
Wyoming	***	0.7	***	***	***	***	1.3

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[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

***Standard error cannot be accurately determined.

* Twenty-one percent of students received no science instruction as reported by their schools.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.4 Standard Errors for Schools' Reports on Years of Science Required for Graduation: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

Beginning with 9th grade, how many years of course work does your school or district require for graduation this year?	**Grade 12** **Percentage, Average Scale Score, and Achievement Level of Students**
1 Year	
Percentage of Students	2.2
Average Scale Score	1.5
Percentage At or Above *Proficient*	3.1
2 Years	
Percentage of Students	4.3
Average Scale Score	1.4
Percentage At or Above *Proficient*	1.7
3 Years	
Percentage of Students	3.9
Average Scale Score	2.0
Percentage At or Above *Proficient*	2.0
4 Years	
Percentage of Students	0.8
Average Scale Score	***
Percentage At or Above *Proficient*	***

NOTE: This table contains information obtained from a derived variable. Please refer to the derived variable section in Appendix A for more details.
***Standard error cannot be accurately determined.
SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.5 Standard Errors for Students' Reports on Semester Hours of Science Taken from Grades 9 - 12: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

From the beginning of 9th grade through the end of the school year, how many semester hours (or equivalent) of course work will you have taken in science?	**Percentage of Students**	**Average Scale Score**	**Percentage At or Above *Proficient***
Grade 12			
None - 1	0.3	3.6	0.9
2 - 3 Semesters	0.7	1.3	0.8
4 - 5 Semesters	1.0	1.6	1.8
6 - 7 Semesters	0.9	0.9	2.1
8 or More Semesters	1.2	1.1	1.9

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.6 Standard Errors for Schools' Reports on Types of Advanced Level Courses Taught: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

Are courses of at least one semester in length taught in your school in each of the following subjects? **Grade 12**	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Advanced Biology	2.9	1.0	1.3
Advanced Chemistry	3.9	1.3	1.6
Advanced Physics	3.8	1.4	1.4
None Taught	2.0	2.8	1.9

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B3.7 Standard Errors for Schools' Reports on Requirements to Pass a District or State Test in Science in Order to Graduate: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD naep

Are students in your school required to pass a district or state test in science in order to graduate?	Yes	No
Grade 12	**Percentage, Average Scale Score, and Achievement Level of Students**	
Percentage of Students	3.4	3.4
Average Scale Score	3.6	1.3
Percentage At or Above *Proficient*	3.5	1.5

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B4.1

Standard Errors for Teachers' Reports on How Much Time is Spent Teaching Certain Science Domains: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

In this class, about how much time do you spend on each of the following areas in science?	Percentage of Students	Average Scale Score				Percentage At or Above *Proficient*
		Composite	Life Science	Earth Science	Physical Science	
Grade 4						
Life Science						
A Lot	2.7	1.5	1.8	1.8	2.0	1.7
Some	2.8	1.2	1.5	1.2	1.6	1.3
Little	1.4	3.8	4.0	3.5	5.2	5.1
None	0.4	***	***	***	***	***
Earth Science						
A Lot	2.1	2.3	2.6	2.9	2.5	2.6
Some	2.4	1.0	1.3	1.2	1.4	1.2
Little	1.0	4.1	4.1	4.5	5.3	4.4
None	0.3	***	***	***	***	***
Physical Science						
A Lot	2.3	2.3	2.8	2.6	2.8	2.3
Some	2.5	1.1	1.5	1.1	1.6	1.4
Little	1.5	3.5	4.0	3.8	4.0	3.5
None	0.5	7.4	7.5	8.6	7.4	5.9

***Standard error cannot be accurately determined.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B4.2

Standard Errors for Teachers' Reports on How Much Time is Spent Teaching Certain Science Domains: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

In this class, about how much time do you spend on each of the following areas in science?	Percentage of Students	Average Scale Score				Percentage At or Above *Proficient*
		Composite	Life Science	Earth Science	Physical Science	
Grade 8						
Life Science						
A Lot	4.1	2.5	2.8	2.9	2.8	3.4
Some	5.3	2.4	2.5	2.5	2.5	2.5
Little	3.6	2.7	2.5	3.1	2.8	3.5
None	4.5	4.0	4.7	4.4	3.2	5.9
Earth Science						
A Lot	5.0	2.5	2.6	2.8	2.5	3.0
Some	4.5	2.1	2.2	2.1	2.1	2.3
Little	2.7	4.7	4.7	5.5	4.2	6.7
None	1.9	3.5	4.4	3.8	3.2	5.2
Physical Science						
A Lot	4.3	1.7	2.1	1.8	1.6	2.4
Some	4.4	2.7	2.7	2.9	2.9	3.2
Little	3.2	3.3	3.4	4.4	2.9	3.5
None	1.2	6.4	6.9	7.0	6.2	5.3

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B4.3

Standard Errors for Students' Reports on Science Course-Taking: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

Which best describes the science course you are taking?	Percentage of Students	Average Scale Score				Percentage At or Above *Proficient*
		Composite	Life Science	Earth Science	Physical Science	
Grade 8						
Life Science	1.4	2.9	3.1	2.7	3.4	2.9
Physical Science	2.4	1.6	2.0	1.7	1.4	2.6
Earth Science	2.7	2.8	2.8	3.2	2.7	3.4
General Science	1.3	1.6	1.7	1.7	1.9	2.2
Integrated Science	1.5	1.5	1.6	1.7	1.7	2.0
No Science	0.8	3.2	3.8	3.7	3.1	2.7

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B4.4a

Standard Errors for Students' Reports on Science Courses Taken from Grades 9 - 12, by Gender: Public and Nonpublic Schools Combined

From the beginning of 9th grade to the present, how much science coursework have you completed in the following subjects?	All Students		Males		Females	
	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None
Grade 12						
Biology						
Percentages of Students	0.5	0.5	0.7	0.7	0.5	0.5
Average Scale Score	0.8	3.1	1.2	3.9	0.9	4.1
Percentages At or Above *Proficient*	1.2	1.9	1.8	2.6	1.3	2.3
Chemistry						
Percentages of Students	1.2	1.2	1.4	1.4	1.3	1.3
Average Scale Score	0.9	1.4	1.2	1.8	1.0	1.6
Percentages At or Above *Proficient*	1.3	1.7	1.8	2.5	1.5	1.2
Physics						
Percentages of Students	1.3	1.3	1.4	1.4	1.5	1.5
Average Scale Score	1.2	0.9	1.5	1.5	1.2	1.0
Percentages At or Above *Proficient*	1.9	1.1	1.9	2.1	2.6	0.9

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B4.4b

Standard Errors for Students' Reports on Science Courses Taken from Grades 9 - 12, by Gender: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

From the beginning of 9th grade to the present, how much science coursework have you completed in the following subjects?	All Students		Males		Females	
	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None	More than 1 Year, 1 Year, Less than 1 Year	None
Grade 12						
Earth & Space						
Percentages of Students	1.8	1.8	1.9	1.9	2.1	2.1
Average Scale Score	1.4	1.3	1.5	2.1	1.7	1.2
Percentages At or Above *Proficient*	1.4	1.6	1.6	2.8	1.9	1.4
Life Science						
Percentages of Students	1.1	1.1	1.5	1.5	1.3	1.3
Average Scale Score	1.2	1.1	1.5	1.5	1.4	1.3
Percentages At or Above *Proficient*	1.8	1.5	2.5	2.0	1.8	1.6
Physical Science						
Percentages of Students	1.8	1.8	2.1	2.1	1.9	1.9
Average Scale Score	1.2	1.1	1.6	1.4	1.4	1.3
Percentages At or Above *Proficient*	1.3	1.6	2.3	2.0	1.2	1.9
General Science						
Percentages of Students	1.3	1.3	1.6	1.6	1.5	1.5
Average Scale Score	1.0	1.3	1.4	1.6	1.1	1.5
Percentages At or Above *Proficient*	1.3	1.9	1.7	2.4	1.2	2.1
Integrated Science						
Percentages of Students	0.6	0.6	0.8	0.8	0.8	0.8
Average Scale Score	2.6	0.9	3.5	1.3	4.7	1.0
Percentages At or Above *Proficient*	2.4	1.3	3.2	2.0	3.8	1.3
Science & Technology						
Percentages of Students	0.7	0.7	1.2	1.2	0.7	0.7
Average Scale Score	1.9	0.9	2.2	1.2	2.8	1.0
Percentages At or Above *Proficient*	2.7	1.3	3.0	1.9	4.0	1.3
Other Science						
Percentages of Students	1.2	1.2	1.4	1.4	1.3	1.3
Average Scale Score	1.3	1.0	1.7	1.5	1.6	1.1
Percentages At or Above *Proficient*	1.4	1.4	2.0	2.3	2.3	1.4

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

THE NATION'S REPORT CARD

TABLE B4.5 Standard Errors for Students' Reports on Combinations of Science Courses Taken from Grades 9 - 12, by Gender: Public and Nonpublic Schools Combined

From the beginning of 9th grade to the present, how much science coursework have you completed in the following subjects?	**All Students**		**Males**		**Females**	
	More than 1 Year, 1 Year, Less than 1 Year	**None**	**More than 1 Year, 1 Year, Less than 1 Year**	**None**	**More than 1 Year, 1 Year, Less than 1 Year**	**None**
Grade 12						
Earth & Biology						
Percentages of Students	1.7	1.7	1.9	1.9	1.9	1.9
Average Scale Score	1.3	1.2	1.4	1.8	1.6	1.1
Percentages At or Above *Proficient*	1.5	1.6	1.7	2.5	1.9	1.5
Earth & Chemistry						
Percentages of Students	1.5	1.5	1.6	1.6	1.8	1.8
Average Scale Score	1.4	1.1	1.6	1.5	1.8	1.1
Percentages At or Above *Proficient*	1.8	1.5	2.1	2.3	2.4	1.3
Earth & Physics						
Percentages of Students	0.9	0.9	1.0	1.0	1.1	1.1
Average Scale Score	1.9	0.9	2.3	1.3	2.2	0.9
Percentages At or Above *Proficient*	2.7	1.2	2.7	2.0	3.9	1.1
Biology & Chemistry						
Percentages of Students	1.3	1.3	1.4	1.4	1.4	1.4
Average Scale Score	0.9	1.2	1.2	1.7	1.0	1.4
Percentages At or Above *Proficient*	1.3	1.5	1.9	2.0	1.5	1.3
Biology & Physics						
Percentages of Students	1.2	1.2	1.3	1.3	1.5	1.5
Average Scale Score	1.1	0.9	1.4	1.3	1.3	1.0
Percentages At or Above *Proficient*	1.8	1.0	2.0	1.8	2.6	0.9
Chemistry & Physics						
Percentages of Students	1.2	1.2	1.4	1.4	1.5	1.5
Average Scale Score	1.1	0.8	1.5	1.2	1.2	1.0
Percentages At or Above *Proficient*	1.9	1.1	2.0	2.0	2.7	1.0
Earth, Biology & Chemistry						
Percentages of Students	1.5	1.5	1.5	1.5	1.8	1.8
Average Scale Score	1.4	1.1	1.5	1.5	1.8	1.1
Percentages At or Above *Proficient*	1.9	1.5	2.1	2.2	2.4	1.3
Earth, Biology & Physics						
Percentages of Students	0.9	0.9	1.0	1.0	1.0	1.0
Average Scale Score	1.8	0.9	2.2	1.3	2.1	0.9
Percentages At or Above *Proficient*	2.8	1.2	2.9	2.0	3.8	1.1
Earth, Chemistry & Physics						
Percentages of Students	0.8	0.8	1.0	1.0	1.0	1.0
Average Scale Score	1.8	0.9	2.3	1.3	2.1	0.9
Percentages At or Above *Proficient*	2.9	1.2	3.1	2.0	3.9	1.1
Biology, Chemistry & Physics						
Percentages of Students	1.2	1.2	1.3	1.3	1.4	1.4
Average Scale Score	1.1	0.9	1.5	1.2	1.2	0.9
Percentages At or Above *Proficient*	1.8	1.1	2.1	1.8	2.6	1.0
Earth, Biology, Chemistry & Physics						
Percentages of Students	0.8	0.8	1.0	1.0	1.0	1.0
Average Scale Score	1.8	0.9	2.3	1.3	2.1	0.9
Percentages At or Above *Proficient*	3.0	1.2	3.3	1.9	3.9	1.1

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B4.6

Standard Errors for Students' Reports on Current Science Course-Taking: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

Are you currently taking a science course this year?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 12			
Yes	1.2	1.1	1.6
No	1.2	0.9	0.9

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B5.1

Standard Errors for Teachers' Reports on Whether They Receive the Resources They Need: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

Which of the following statements is true about how well your school system provides you with instructional materials and other resources you need?	Percentage of Students	Average Scale Score	Percentage At or Above *Proficient*
Grade 4			
All or Most	2.7	1.1	1.4
Some	2.7	1.4	1.6
None	***	***	***
Grade 8			
All or Most	3.7	1.6	2.1
Some	3.8	1.9	2.2
None	0.4	6.4	5.6

***Standard error cannot be accurately determined.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B5.2 and FIGURE B5.1

Standard Errors for Teachers' Reports on Whether They Receive the Resources They Need, for the Nation and Jurisdictions: Public Schools Only

THE NATION'S REPORT CARD naep

Which of the following statements is true about how well your school system provides you with instructional materials and other resources you need?	All or Most		Some		None		
	% of Students	Average Scale Score	% of Students	Average Scale Score	% of Student	Average Scale Score	Total % At or Above *Proficient*
Grade 8							
Nation	4.1	1.8	4.1	2.0	0.4	6.5	1.3
Alabama	4.9	3.4	4.6	2.7	2.0	***	1.5
Alaska[a]	2.9	1.7	2.9	3.2	***	***	1.6
Arizona	5.1	2.4	4.9	2.6	0.8	***	1.7
Arkansas[a]	4.9	1.8	4.9	3.1	***	***	1.5
California	4.1	2.5	4.2	2.7	0.8	***	1.7
Colorado	3.6	1.5	3.5	2.0	0.3	***	1.2
Connecticut	3.7	1.4	4.2	3.9	1.5	3.8	1.7
Delaware	1.0	1.7	1.1	1.3	0.5	7.3	1.0
DDESS	1.6	1.7	1.6	***	***	***	2.2
DoDDS	1.0	0.9	1.0	***	0.2	***	1.3
District of Columbia	0.7	3.0	0.6	1.0	0.9	2.6	0.9
Florida	4.5	2.5	4.2	2.3	1.3	6.6	1.6
Georgia	3.2	1.9	3.0	2.5	0.8	***	1.7
Guam	1.0	3.6	1.0	1.4	***	***	1.0
Hawaii	1.2	2.3	1.2	1.6	0.2	***	1.0
Indiana	4.5	1.7	4.5	2.4	***	***	1.9
Iowa[a]	3.4	1.2	3.2	2.6	***	***	1.6
Kentucky	4.3	1.9	4.3	2.4	***	***	1.3
Louisiana	3.9	2.6	4.4	2.4	3.3	4.4	1.2
Maine	3.8	1.3	3.7	1.6	1.0	4.5	1.8
Maryland[a]	4.8	2.2	4.8	2.6	***	***	1.8
Massachusetts	3.8	2.1	3.9	2.1	1.3	***	1.7
Michigan[a]	4.6	1.8	4.5	3.0	***	***	2.0
Minnesota	5.1	1.4	4.7	2.0	***	***	1.7
Mississippi	4.7	2.1	4.8	2.5	1.4	4.3	1.0
Missouri	4.1	1.6	4.1	2.1	0.1	***	1.3
Montana[a]	4.0	1.4	4.0	1.9	0.1	***	2.1
Nebraska	2.6	1.2	2.6	1.3	***	***	1.5
New Mexico	2.3	1.3	2.3	1.4	0.5	3.0	0.7
New York[a]	4.4	2.3	4.4	3.4	0.6	***	1.7
North Carolina	4.4	1.4	4.5	1.8	1.2	***	1.4
North Dakota	2.8	0.9	2.8	1.5	***	***	1.5
Oregon	4.7	2.0	4.7	2.2	0.2	***	1.8
Rhode Island	1.0	1.0	1.0	1.2	***	***	1.5
South Carolina[a]	4.8	2.1	4.8	2.3	***	***	1.4
Tennessee	5.3	2.6	5.1	2.4	0.8	***	1.7
Texas	3.4	1.5	3.3	2.5	1.0	***	1.5
Utah	2.8	1.2	2.8	1.3	0.3	***	1.2
Vermont[a]	3.0	1.5	3.0	1.4	***	***	1.6
Virginia	3.2	2.2	3.2	2.9	***	***	2.1
Washington	4.1	1.8	4.1	2.7	***	***	1.6
West Virginia	4.1	1.5	4.0	1.4	0.4	***	1.1
Wisconsin[a]	5.2	2.4	5.2	2.5	***	***	1.9
Wyoming	0.7	0.8	0.7	1.2	0.2	***	1.3

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

***Standard error cannot be accurately determined.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE B5.2 Standard Errors for Teachers' Reports on Availability of Computers for Use by Their Science Students: Public and Nonpublic Schools Combined

Which best describes the availability of computers for use by your science students?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
None		
Percentage of Students	1.9	3.1
Average Scale Score	3.3	5.0
Percentage At or Above *Proficient*	3.1	6.5
One or More in Classrooms		
Percentage of Students	4.0	4.4
Average Scale Score	1.4	1.3
Percentage At or Above *Proficient*	1.7	2.5
Computer Laboratories (Difficult Access)		
Percentage of Students	2.7	4.5
Average Scale Score	2.6	1.9
Percentage At or Above *Proficient*	3.5	2.4
Computer Laboratories (Easy Access)		
Percentage of Students	2.8	2.4
Average Scale Score	2.6	2.2
Percentage At or Above *Proficient*	2.6	2.4

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

TABLE B5.3 and FIGURE B5.3

Standard Errors for Teachers' Reports on Availability of Computers for Use by Their Science Students, for the Nation and Jurisdictions: Public Schools Only

Which best describes the availability of computers for use by your science students?	None	One or More in Classrooms	Computer Laboratory (Difficult Access)	Computer Laboratory (Easy Access)	Total % At or Above *Proficient*
Grade 8	**Percentage of Students**				
Nation	3.4	5.0	4.9	2.6	1.3
Alabama	3.6	4.1	4.5	1.7	1.5
Alaska[a]	1.4	3.5	3.6	2.4	1.6
Arizona	4.2	4.6	3.5	3.5	1.7
Arkansas[a]	5.1	4.4	5.9	1.9	1.5
California	3.2	4.0	3.2	2.9	1.7
Colorado	2.4	3.8	3.5	2.4	1.2
Connecticut	3.0	3.9	3.6	2.6	1.7
Delaware	0.9	0.7	1.0	0.5	1.0
DDESS	***	1.2	1.2	0.7	2.2
DoDDS	0.7	0.8	0.7	0.4	1.3
District of Columbia	1.3	1.0	0.8	0.5	0.9
Florida	3.5	4.7	3.1	1.9	1.6
Georgia	2.6	3.9	3.5	2.5	1.7
Guam	1.1	1.0	1.4	***	1.0
Hawaii	0.7	1.1	1.0	0.9	1.0
Indiana	3.8	4.0	5.2	3.3	1.9
Iowa[a]	2.7	5.4	5.2	2.8	1.6
Kentucky	2.1	4.6	4.5	3.3	1.3
Louisiana	4.5	3.2	3.1	3.0	1.2
Maine	2.2	3.9	4.3	1.8	1.8
Maryland[a]	1.9	3.8	4.6	4.3	1.8
Massachusetts	3.0	4.2	4.1	3.1	1.7
Michigan[a]	4.2	3.7	4.7	4.2	2.0
Minnesota	3.0	4.1	4.0	3.3	1.7
Mississippi	4.3	3.4	3.5	2.8	1.0
Missouri	3.0	4.3	4.2	2.9	1.3
Montana[a]	2.6	4.5	4.6	1.7	2.1
Nebraska	1.3	3.5	3.2	2.4	1.5
New Mexico	2.3	2.4	2.5	1.3	0.7
New York[a]	4.6	4.0	4.8	3.5	1.7
North Carolina	2.7	3.8	3.9	3.2	1.4
North Dakota	1.5	2.7	2.6	1.9	1.5
Oregon	2.8	4.9	4.5	2.7	1.8
Rhode Island	0.7	0.7	0.9	0.7	1.5
South Carolina[a]	3.9	4.0	4.3	2.3	1.4
Tennessee	4.0	4.6	3.2	2.4	1.7
Texas	3.4	5.0	3.5	2.1	1.5
Utah	2.1	2.3	1.9	2.2	1.2
Vermont[a]	2.0	3.0	2.3	3.0	1.6
Virginia	2.2	3.8	4.0	3.0	2.1
Washington	2.4	4.4	4.1	3.6	1.6
West Virginia	3.6	3.8	3.7	2.0	1.1
Wisconsin[a]	2.6	5.1	4.9	3.6	1.9
Wyoming	0.6	1.2	1.1	0.5	1.3

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

***Standard error cannot be accurately determined.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE B5.4

Standard Errors for Teachers' Reports on Availability of a Curriculum Specialist in Science: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

Is there a curriculum specialist available to help or advise you in science?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
Yes		
Percentage of Students	3.3	3.4
Average Scale Score	1.4	2.5
Percentage At or Above *Proficient*	1.7	2.8
No		
Percentage of Students	3.3	3.4
Average Scale Score	1.4	1.4
Percentage At or Above *Proficient*	1.8	2.3

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE B5.5

Standard Errors for Teachers' Reports on Availability of a Curriculum Specialist in Science, for the Nation and Jurisdictions: Public Schools Only

Grade 8 **Nation 3.9 1.3**

Jurisdictions where the percentage is above the national average		Total % At or Above *Proficient*	Jurisdictions where the percentage does not differ from national average		Total % At or Above *Proficient*	Jurisdictions where the percentage is below the national average		Total % At or Above *Proficient*
District of Columbia	1.7	0.9	Alabama	4.8	1.5	Arkansas[a]	3.8	1.5
Florida	3.3	1.6	Alaska[a]	2.9	1.6	Indiana	4.0	1.9
Georgia	3.3	1.7	Arizona	4.8	1.7	Maine	3.6	1.8
Louisiana	4.7	1.2	California	4.4	1.7	Montana[a]	3.8	2.1
Maryland[a]	4.1	1.8	Colorado	3.8	1.2	New Mexico	2.1	0.7
North Carolina	3.6	1.4	Connecticut	3.9	1.7	North Dakota	1.9	1.5
Texas	4.0	1.5	Delaware	0.9	1.0	Oregon	3.7	1.8
Utah	2.8	1.2	DDESS	1.8	2.2	Rhode Island	1.0	1.5
Virginia	4.0	2.1	DoDDS	1.3	1.3	Vermont[a]	2.0	1.6
West Virginia	3.9	1.1	Guam	1.3	1.0	Wyoming	1.0	1.3
			Hawaii	1.0	1.0			
			Iowa[a]	5.1	1.6			
			Kentucky	3.9	1.3			
			Massachusetts	4.9	1.7			
			Michigan[a]	4.2	2.0			
			Minnesota	4.3	1.7			
			Mississippi	4.5	1.0			
			Missouri	4.3	1.3			
			Nebraska	3.0	1.5			
			New York[a]	4.4	1.7			
			South Carolina[a]	4.5	1.4			
			Tennessee	4.2	1.7			
			Washington	4.7	1.6			
			Wisconsin[a]	4.2	1.9			

[a] Failed to meet one or more of the participation-rate guidelines for public schools; public school results reported with appropriate notation.

SOURCE: National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 1996 Science Assessment.

FIGURE B5.6

Standard Errors for Teachers' Reports on What Space is Available for Teaching Science: Public and Nonpublic Schools Combined

THE NATION'S REPORT CARD

Which of the following best describes the space where this class is taught?	Grade 4	Grade 8
	Percentage, Average Scale Score, and Achievement Level of Students	
Classroom with no access to laboratory or water source		
Percentage of Students	3.1	2.0
Average Scale Score	1.9	3.1
Percentage At or Above *Proficient*	2.5	3.6
Classroom with access to water source only		
Percentage of Students	3.2	3.6
Average Scale Score	1.4	1.8
Percentage At or Above *Proficient*	1.6	2.3
Classroom with access to laboratory only		
Percentage of Students	0.6	3.2
Average Scale Score	6.4	3.8
Percentage At or Above *Proficient*	6.2	5.8
A laboratory with water source		
Percentage of Students	0.8	4.3
Average Scale Score	4.5	1.7
Percentage At or Above *Proficient*	7.5	2.6

Acknowledgments

This report is the culmination of the efforts of many individuals who contributed their considerable knowledge, experience, and creativity to the NAEP 1996 science assessment. The NAEP 1996 science assessment was a collaborative effort among staff from the National Center for Education Statistics (NCES), the National Assessment Governing Board (NAGB), Educational Testing Service (ETS), Westat, and National Computer Systems (NCS). In addition, the program benefited from the contributions of hundreds of individuals at the state and local levels — governors, chief state school officers, state and district test directors, state coordinators, and district administrators — who tirelessly provided their wisdom, experience, and hard work. Most importantly, NAEP is grateful to the thousands of students and hundreds of teachers and administrators who made the assessment possible.

The NAEP 1996 science assessment was funded through NCES, in the Office of Educational Research and Improvement of the U.S. Department of Education. The Commissioner of Education Statistics, Pascal D. Forgione, and the NCES staff — Peggy Carr, Arnold Goldstein, Steven Gorman, Gary W. Phillips, and Larry Ogle — worked closely and collegially with the authors to produce this report. The authors were also provided invaluable advice and guidance by the members of the National Assessment Governing Board, NAGB staff, and the Science Standing Committee. In particular, the authors are indebted to Arnold Goldstein of NCES for his daily efforts to coordinate the activities of the many people who contributed to this report.

The NAEP project at ETS is housed in the Center for the Assessment of Educational Progress under the direction of Paul Williams. The NAEP 1996 assessments were directed by Stephen Lazer and John Mazzeo. Tom Corley, Lee Jones, Tim Ligget, Beth Nichols, Christine O'Sullivan, Amy Pearlmutter, Will Pfeiffenberger, Mario Yepes-Baraya, and Ann Marie Zolandz worked with the Science Instrument Development Committee to develop the assessment instrument. Sampling and data collection activities were conducted by Westat under the direction of Rene Slobasky, Nancy Caldwell, Keith Rust, and Dianne Walsh. Printing, distribution, scoring, and processing activities were conducted by NCS under the direction of Brad Thayer, Patrick Bourgeacq, Charles Brungardt, Mathilde Kennel, Linda Reynolds, and Brent Studer.

The statistical and psychometric activities for NAEP at ETS are directed by Nancy Allen, John Barone, James Carlson, and Juliet Shaffer. The analyses presented in this report were led by John Donoghue and Steven Isham with assistance from Jinming Zhang, Spencer Swinton, Lois Worthington, Inge Novatkoski, Bruce Kaplan, Dave Freund, and Kate Pashley.

The design and production of the report was overseen by Jan Askew, Carol Errickson, and Kellie Keiser. The considerable production efforts were completed by Loretta Casalaina, Sharon Davis-Johnson, and Barbette Tardugno. The production of the World Wide Web version of this report was led by Patricia O'Reilly with assistance from Jim Rura, Phillip Leung, and Debbie Kline.

Many thanks are due to the numerous reviewers, both internal and external to NCES and ETS. The comments and critical feedback of the following reviewers are reflected in this report: Mary Lyn Bourque, Audrey Champagne, Lawrence Feinberg, Henry Heikkinen, Andrew Kolstad, Michelle Leon, Laura Lippman, Marilyn McMillen, Wayne Martin, Senta Raizen, Thomas Sachse, Sylvia Ware, Arthur Williams, David Williams, and Shi-Chang Wu.

ISBN 0-16-049733-7
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9 780160 497339

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